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SOLID WASTE MANAGEMENT: ABSTRACTS FROM
THE LITERATURE, 1968

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SOLID WASTE MANAGEMENT

Abstracts from the Literature—1968

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SOLID WASTE MANAGEMENT BIBLIOGRAPHIC SERIES

1941- 1971

Since its beginning more than a quarter of a century ago, the Federal program in solid waste management has had a number of organizational changes, as well as several organizational titles. One constant, though, has been quite visible throughout the program's development, and that is its unflagging interest in bibliography.

Collecting past data on a problem by a literature search is the classic first step used in the scientific method of problem solving. Thus, in 1941, the first workers in the Federal program searched the world-wide literature for information that had been published on solid wastes. The resultant bibliography was then published as a service to other workers in the field and became a periodic publication in the Public Health Service series. This step was taken again in 1965, following the passage of the Solid Waste Disposal Act, when the early bibliographies were reprinted and made more widely available. The literature search was then extended through 1971, and the present bibliography is one of those that will bring the series up to date.

SAMUEL HALE, JR.

*Deputy Assistant Administrator
for Solid Waste Management*

SOLID WASTE MANAGEMENT

Abstracts from the Literature

1968

The Solid Waste Disposal Act of 1965 (Public Law 89-272, Title II) and its amended legislation, the Resource Recovery Act of 1970 (Public Law 91-512, Title I), authorized collection, storage, and retrieval of information relevant to all aspects of solid waste management.

Although the literature represented by this bibliography does not include all the solid waste literature published in 1968 numerous periodical and nonperiodical titles covering both the foreign and domestic literature were screened for inclusion. No effort was made to separate strictly technical material from that which is more general. The bibliography is arranged in categories corresponding to the various administrative, engineering, and operational phases of solid waste management. Indices include subject, corporate author, author, and geographical location cited. Addresses of periodical sources are provided.

This project is the result of the combined efforts of the Solid Waste Information Retrieval System (SWIRS) and the Franklin Institute Research Laboratories under contracts PH 86-67-182 and PH 86-68-194. Primary SWIRS personnel involved in this project were John A. Connolly and Sandra E. S'ainback.

—THOMAS F. WILLIAMS, *Director*
Technical Information Staff
Office of Solid Waste Management Programs

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LAW/REGULATIONS

68-0001

Breidenbach, A. W. Research activities of the Solid Wastes Program of the Public Health Service. [Cincinnati], U.S. Department of Health, Education, and Welfare, Mar. 1968. 16 p.

The objectives of the Solid Waste Disposal Act of 1965 are to initiate and accelerate a national research and development program for methods of solid waste disposal, and to provide technical and financial assistance to appropriate agencies in the planning, development, and conduct of solid waste disposal programs. The Congress assigned responsibility for administering the Solid Waste Disposal Act to the Secretary of Health, Education, and Welfare and to the Secretary of the Interior. The Program functions through four distinct activities: Systems Analysis and Operations Planning, Technical Services, Demonstrations, and Research and Development. The seven recommendations of the National Commission of Technology, Automation, and Economic Progress are presented. The distribution of funds and projects of the Solid Wastes Program are tabulated.

68-0002

Disposal problem outweighs judicial technicalities, rules New York Supreme Court. *Clean Air News*, 2(14):2-3, Apr. 23, 1968.

In a case involving suits by two New York towns against a contracting company to prohibit the open burning of trees, stumps, and other debris, the New York Supreme Court ruled that the materials be immediately burned because of the urgency and complexity of the disposal problem. The case involved the debris, such as trees and stumps, resulting from clearing areas to build a highway. The State Department of Health expressed concern as to whether such burning would violate the State's air pollution control laws, but the court had no jurisdiction in this matter.

68-0003

Milliken, S. O., M. D. Strauss, and R. Black. Legal responsibilities for sewage disposal in an urban county. *American Journal of Public Health*, 58(1):122-130, Jan. 1968.

A case study of the Cincinnati metropolitan area with respect to the legal responsibilities for sewage disposal is presented. The finding in this case is that the local health officer and his agency are practically impotent legally. Effective community health planning must be appropriately area-wide in scope. It must deal realistically with the limitations and potentials of existing legal authority and responsibility; it must bring to bear the powers of governmental agencies along with the powers and flexibilities of voluntary agencies; and it must work to overcome obstacles created by man-made boundaries. The responsibilities of various local government units in sewage disposal regulations are outlined.

68-0004

Public corporation proposed to handle solid wastes. *Compost Science*, 9(2):5-6, Summer 1968.

A bill introduced into the New York State Senate would create a public corporation whose purpose would be to improve the handling of solid wastes, to reduce environmental pollution, and to provide for effective utilization of waste material. The text of the bill is included. The corporation would be governed by a board of directors appointed by the Governor with the consent of the Senate. The powers of the corporation would include: developing procedures for reclaiming wastes; regulating the design and composition of disposable containers; providing for the removal and disposition of abandoned automobiles; encouraging new technology for handling and disposal; assisting in the construction of multiple-use facilities; sponsoring conferences and studies; and receiving, investing, and using property and money. The property, income, and activities of the corporation would be exempt from taxes and assessments.

68-0005

Removal and disposal of vehicles; law relative to the subject. *Public Cleansing*, 58(7):325-330, July 1968.

'Disposal of Old Motor Vehicles,' Circular No. 8/65, issued by the British Ministry of Housing and Local Government in February 1965, enumerates the powers of a local authority in dealing with abandoned cars. Section 74 of the Public Health Act of 1936 enables a local authority to remove, on request, refuse which it is under no obligation to remove, and the circular treats such articles as old motor cars as refuse within the meaning of the section. Section 34 of the Public Health Act of 1961 enables a local authority to remove from vacant sites any accumulations of rubbish which are detrimental to the area. The Removal of Vehicles Regulations of 1961 enables local authorities to dispose of vehicles which are abandoned on roads. Part III of the Civic Amenities Act of 1967 provides for the disposal of abandoned vehicles and other refuse. Individual sections of that act are analyzed. Statutory Instrument No. 43, entitled 'The Removal and Disposal of Vehicles Regulation, 1968,' now constitutes the law for the removal and disposal of vehicles abandoned on the road or on land. The charges are prescribed, and these regulations are summarized.

68-0006

Solid Waste Disposal Act Amendment of 1968. Report of the Committee on Public Works, U.S. Senate, to accompany S.3201, 90th Cong., 2d sess., Report No. 1447. Washington, U.S. Government Printing Office, 1968. 33 p.

The purpose of bill S.3201 is to amend the Solid Waste Disposal Act (Public Law 89-272, Title II) to protect the public's health by extending for 1 year the provisions on research and assistance for State and interstate planning for solid waste disposal. This one-year extension will provide sufficient time to conduct the study, recommended by the President, to bring down the present high cost of solid waste disposal and to improve research and development in this

Economics

field. Working with representatives of the Department of Health, Education, and Welfare, the Department of the Interior, and the Department of Defense, Dr. Rolf Eliassen, a professor of environmental engineering at Stanford University, is undertaking a comprehensive review of solid waste technology. Statements of various agencies, listings of State-interstate solid waste planning grants, and changes in the existing law are included.

68-0007

State regulation of solid waste disposal. Public Works, 99(5):102, May 1968.

Under a law passed by the Ohio Assembly, the State will regulate and health districts will license the location and operation of solid waste disposal sites and facilities. The term 'solid waste' as defined here does not include earth or material from construction, mining, and demolition operations, nor slag and other substances which are not harmful to public health. The State Public Health Council is required to adopt regulations having uniform application throughout the State. The law requires the regulation and licensing to insure that sites and facilities will be located, maintained, and operated in a sanitary manner. Anyone desiring to establish a disposal site must submit the plans for the facility to the State Health Department. Provision is made requiring annual inspections, and a license may be revoked or denied after a hearing.

ECONOMICS

68-0008

Buell, D. Private industry might cut red tape—solid waste disposal—IV. Congressional Record, 114(42):S2,845, Mar. 14, 1968.

At a rate of \$5,000 rent for the land, Melrose, Massachusetts, plans to let a private company build an incinerator for the town. The city is therefore released from the necessity of floating a \$1.5 to \$2 million bond issue to maintain and operate the incinerator, and can defray the cost of the bond issue. Private companies, by receiving tax incentives to install new parts, have advantages that municipalities lack. Municipalities, because of low salaries, usually cannot keep skilled laborers to operate disposal systems. Padding the sanitation department with political appointees can also be avoided.

68-0009

Chamberlain, G. M. Guaranteed-maintenance purchasing. American City, 83(6):112-114, June 1968.

Low-bid buying, under old bidding procedures, generally meant that the city could wind up with third-rate equipment, low in initial cost but expensive to maintain. Guaranteed-maintenance purchasing means that dealers must stand behind their product beyond the normal warranty period. Also, it helps to cut down on costly repairs that always seem to occur shortly after the warranty expires. At last count, some 65 municipalities and nearly 40 counties in 28 States have bought equipment covered by a

guaranteed-maintenance contract. Under guaranteed-maintenance bidding, the bidder must furnish a bid price for the outright purchase of the equipment and a guaranteed-maintenance cost for the expected useful life of the equipment. Some jurisdictions have carried this one step further to include a guaranteed repurchase price for the equipment at various intervals within the useful life of the equipment. With all three factors included, the procedure is referred to as total-cost bidding or total-life costing. A specific example concerning Chicago's purchase of a crawler tractor is discussed.

68-0010

Chamberlain, G. M. Guaranteed-maintenance purchasing. Part II—what are its disadvantages? American City, 83(7):129-130, July 1968.

Guaranteed-maintenance bidding allows all bidders to meet specifications, and it includes several possible alternatives to help produce the lowest net cost to the city. Also, it gives the municipal official a chance to consider all the costs of equipment, ownership, and maintenance. Yet there are some disadvantages that prohibit many local bodies from participating. Some of these disadvantages are: State and local laws may hinder such bidding; unions may try to curtail this practice; operating departments may oppose it; dealerships or repair shops may not exist locally; cost records to base bids on may not exist; and only a limited number of manufacturers can comply. A purchasing agent's biggest problem in selling guaranteed-maintenance or total-cost bidding is convincing the operating departments of this method's value. Often these departments do not keep accurate cost records of their equipment. As a result, they cannot determine their average monthly maintenance costs. This means the city will have no yardstick with which to evaluate a guaranteed-maintenance bid. Other disadvantages are the increase in needed, initial cash outlay and the possibility of fewer interested bidders.

68-0011

Chamberlain, G. M. Guaranteed-maintenance purchasing. Part III—do manufacturers like it? What are some alternatives? What is its future? American City, 83(8):102, 104-105, 137, Aug. 1968.

Guaranteed-maintenance purchasing procedures are discussed. Some alternatives currently in use in cities are described. A large number of dealers have reported submitting total-cost bids on a growing variety of equipment; yet many of them report a lack of success when one or more of the following factors are involved: the purchasing body may have had inadequate experience or records on which to base a sound total-cost evaluation; although a quality product is clearly indicated, the law or purchasing committee requires the lowest bid be taken; elected officials often stick with low-bid buying out of fear of public criticism. The purchasing official or committee which evaluates all bids on an 'equal basis' may then award the bid based on friendship, a salesman's 'claim,' or a 'buy local' policy. Several factors that make total-cost bidding work more effectively are: requiring all bidders to submit performance bonds with their bids; making specifications clear on all responsibilities for repairs

and downtime charges; spelling out means of arbitration in case of divergent opinions arising from some misunderstanding; requiring all bidders to bid on the same form; checking the bid with the legal department; making sure the buyback is not a trade-in; and being aware of the difference between gear-driven and clock-type hour meters on engines when using these to record running times. Some local governments have tried equipment rental as an alternative. Some advantages of the leasing program are: any unit can be transferred, depending on the work load, from one department to another; if an oversupply of vehicles exists, the extra units can be returned; and rentals allow the district to expend its money over a period of time and not on an original purchase.

68-0012

Frankel, R. J. Technologic and economic interrelationships among gaseous, liquid, and solid wastes in the coal-energy industry. *Journal of the Water Pollution Control Federation*, 40(5):779-788, May 1968.

The importance of a comprehensive waste management approach for analyzing and determining the minimum total costs associated with environmental quality standards is discussed. Two examples are given to illustrate that waste production and waste handling alternatives must be considered in an economic analysis of overall production costs. Tables show: the operating costs for the closed water circuit for handling liquid waste; operating costs for a thermal drying plant; and operating costs for environmental quality control. It is stated that the cost per ton for liquid waste amounts to \$0.06; for solid waste, \$0.035; and for gaseous waste, \$0.021. These figures are applicable for a complete coal preparation plant of 500-ton-per-hr capacity. Based on a disposal tonnage of 370,000 tons per year (or 80% recovery), the operating cost of solid waste disposal per ton of refuse is calculated at \$0.10 per ton. By comparison, this cost of solid waste disposal at the mine is considerably less than the cost at the power plant site where fly ash and bottom ash are disposed of at costs of between \$1.00 and \$2.00 per ton. The capital costs for solid waste handling include conveyors for the dry refuse, crushers, dewatering screens, bins, sumps, bulldozers, and trucks for disposal to designated sites. Estimated capital costs for such facilities are about \$250,000, or approximately 7 percent of the plant cost for refuse handling. Estimated capital costs associated with waste water control, solid waste disposal, and gaseous wastes control amount to \$750,000 or over 20 percent of total plant capital costs. These could double if the coal preparation plant were located near residential communities where particulate emission controls are more stringent. They serve, however, to show that environmental quality control constitutes an important segment of the cost of coal preparation.

68-0013

Lippman, A. J. Spiraling costs mark waste industry over three decades. *Solid Wastes Management/Refuse Removal Journal*, 11(1): 86-87, Jan. 1968.

Costs of wages, materials, supplies, taxes, and equipment for the municipal refuse contractor have risen sharply between 1937 and 1967. Gasoline (taxes included) has increased from

15.98 to 33.90 cents per gal and oil from 35 to 79 cents per qt. Registration fees have nearly doubled for a 30,000-lb truck. Drivers and loaders wages have risen from \$24 and \$21 per week to \$126 and \$116 per week, respectively. Social Security taxes, averaging \$0.48 weekly in 1937, are now \$5.97. A truck which cost \$3,500 in 1937 now costs over \$12,000. The price of a bulldozer (D6, D7, or D8) is now five or six times as high as it was in 1937.

68-0014

Pricing for refuse removal. *Public Cleansing*, 58(2):68-69, Feb. 1968.

In 'Pricing for Refuse Removal,' a prize-winning essay in the *Theory and Practice of Pricing*, published by the Institute of Economic Affairs, the author Sudha Shenoy comes to the conclusions that a market in British refuse should be established and that refuse collection and disposal should not be financed from the rates. A market in refuse disposal would have the effect of curtailing a rising demand for additional refuse removal services, resulting from the increasing volume of refuse. The proposed market in refuse might be based on individual contracts between householders and private firms. Comparisons are made between the British and Indian practices to illustrate that householders could be persuaded to presort their refuse if there was a financial incentive. After analyses of British refuse, it was concluded that it should be possible to reuse most of it by way of salvage, heat recovery, or composting.

68-0015

Ralph Stone and Company, Inc. Preliminary cost analysis. *In* Land reclamation by accelerated stabilization; first annual progress report. Los Angeles, Aug. 1968. p. 13-14.

A preliminary cost analysis of several alternative methods of processing and disposing 250 tons per day of domestic refuse was made. The methods considered were incineration, normal sanitary landfill, composting, and controlled aeration for both biological and in situ incineration. A tributary population of 100,000 was assumed, and the per capita production was estimated to be 5.0 lb per day. The composition was assumed to be 50 percent volatile matter, 25 percent inerts, and 25 percent moisture. The total per ton processing and disposal cost for the case study was projected to be \$8.53 for incineration, \$1.50 for normal sanitary landfill, \$4.29 for composting, and \$1.78 for controlled aeration, disregarding the ultimate value of the completed landfill.

68-0016

\$214 million sought in New York City. *Solid Wastes Management/Refuse Removal Journal*, 11 (2):22-24, 26, Feb. 1968.

Refuse and residue receipts by the New York City Sanitation Department, amounting to 7,200 tons in 1967, are expected to rise to 8,200 tons by 1977. The proposed budget for 1969 to 1974 of \$214 million, is intended to modernize and expand the city's system. Figuring prominently in the above totals are two proposed incinerators, one in the South Bronx

Storage

with a capacity of 3,200 tons per day, and one in the Brooklyn Navy Yard with a daily capacity of 5,000 tons. These would be built at a cost of \$98 million. The balance of the 5-year budget would purchase collection trucks and incinerators with air pollution controls, construct marine transfer stations, and provide marine loading and landfill facilities, including barges. The proposed incinerators are required to meet not only the current demands and those due to normal growth, but also the additional load that will be placed on the city's incineration facilities due to the ultimate prohibition on burning any refuse in apartment house incinerators.

STORAGE

68-0017

Bevan, R. E. Sacks in a city. *Public Cleansing*, 58(8):376-388, Aug. 1968.

Experiments in Manchester, England, using paper sacks for refuse storage have shown that the weight carried by the men and the distance which they have to walk is reduced and that the system is cleaner and quieter than the former method. Public information and education was an integral part of the scheme. Experimentation is still underway regarding the optimum size of the sack opening and the sack's optimum capacity. The cost of the method has not increased since its initiation in 1963. Various problems are discussed such as: the number of sacks to be distributed to each house; the problems which arise when an unexpectedly large amount of rubbish is produced in a particular house; and the changes in the rubbish due to the introduction of 'smokeless zones,' which completely prohibit burning. Plastic sacks were initially considered, but their tendency to rip and the difficulty of disposing of them led to the use of paper sacks.

68-0018

Can we reduce the waste in trash disposal? *Safety Maintenance*, 135(3):43-44, Mar. 1968.

A containerized, disposable paper refuse sack for waste disposal is described. An enclosed cabinet makes the refuse sack system feasible for many areas where waste containers were forbidden due to unsightliness, sanitation problems, or fire hazards. The large capacity of the sack reduces labor costs, and the cabinet itself may be designed to satisfy specific needs. Sacks are provided for dry, greasy, and wet refuse.

68-0019

Collection of industrial waste at Greenock. *Public Cleansing*, 58(6):265-266, June 1968.

The burgh of Greenock, England, has successfully used a large container system for the storage, removal, and disposal of industrial waste. In early 1967, enough factories were interested in an industrial refuse collection scheme to warrant the attention of the Cleansing Committee. On the basis of the capital expenditure for two vehicles and 42 containers, a container rental and replacement fee was agreed upon. The containers used are 8-cu-yd open skips. Container-handling

equipment is mounted on a short wheelbase chassis which is suitable for maneuvering in confined spaces. After 6 months of operation, over 70 containers are in use. Almost all refuse collection and disposal in the town is under the control of the local authority.

68-0020

Containers get into the act. *Public Cleansing*, 58(12):624-634, Dec. 1968.

At a meeting of the North Western Centre at Rochdale, Sept. 27, 1968, Mr. J. B. Carter, Deputy Director of Cleansing, Bury, presented a paper entitled 'Container Services in a Cleansing Department with Particular Reference to the Civic Amenities Act, 1967.' The Council of Bury approved 'the purchase of a vehicle fitted with container-handling equipment together with 12 containers. It also approved setting up 10 disposal sites throughout the district, regarding this as the best way to meet the requirements of the act. A capacity of 10 cu yd was selected for the containers, which were finished in green to conform with the vehicle color and to merge with the shrubbery which is to be a feature of the permanent sites. The containers are emptied, as required, on an interchange basis. Estimated charges and costs, vehicle details, and collection statistics are listed. Maximum publicity was given to the whereabouts of the sites, and no restriction placed on the type of materials to be placed in the container. The operation has been so successful that the introduction of a second vehicle is planned.

68-0021

Hundertmark, G., H. F. Langer, and M. Koeij. Waste containers made of plastic. *Staedtehygiene*, 19(8):168-172, Aug. 1968.

Since the specific weight of the wastes is becoming increasingly lower, and it is not efficient to use containers which are actually heavier than the waste itself, the use of plastic containers is becoming increasingly popular. The new low-pressure polyethylene waste containers (110, 90, and 70 liter, as well as 50 and 35 liter) are shaped such that they can be emptied into the conventional waste-collecting trucks, and their dimensions correspond to modern standards. The experience gathered with such containers in the winter of 1962 to 1963 showed that normal low-pressure polyethylene is not sturdy enough. Thus a new material was used for the containers. It is a special type of low-pressure polyethylene called Vestolen (density 0.960 g per cu m, softening point 124°C). The plastic containers must be shockproof. With Vestolen A 6014, excellent results were obtained in this respect. Moreover, it is very resistant to chemicals as well as to varying weather conditions. Experiments performed with these plastic containers show that they are also quite fireproof. No glowing cigarette or burning match could inflame the container with its lid closed. Various tests were performed with the Vestolen containers since city administrations asked for quality checks. The containers were stored for 2 days at a temperature of 95°C plus or minus 3°C. Fall, tilting, and spinning experiments, as well as a hanging test at 20 and 40 degrees, were performed. The latter test was performed to determine the deformation of the containers under stress. All tests brought completely satisfying results. (Text in German)

68-0022

McElwee, W. C., and M. J. Wilcomb. Some effects of disposable plastic liners on refuse handling efficiency. *Journal of Environmental Health*, 30(5):501-509, Mar.-Apr. 1968.

Use of plastic disposable liners for refuse containers in Lebanon, Ohio, a city of 8,000, resulted in a 20-percent reduction in loading time and a 12-percent reduction in overall collection time. The liners were Virgin RHX-Elastomer modified high density ethylene copolymer, 30 by 37 in., and 0.00125 in. thick. Its minimum liquid strength is 60 lb, and its tensile strength is 2,900 lb per sq in. They cost about 7 cents apiece. Paper-covered wire twists are provided. Data from studies indicated that liners appear to have a clear advantage over conventional cans with reference to speed of collection from curb to truck. The liners are fairly strong, and spillage and breakage occurred only rarely when the sacks were overfilled. Dog damage was less for liners than for cans. Weather had no effect on the liners, while cardboard boxes tended to disintegrate. The liners were often used with conventional cans, in which case they would prolong the life of these containers by protecting them from rust and garbage damage. Data from the studies are fully reported with graphs and tables, and the results indicate a mean difference of 13.7 seconds plus or minus 1.7 seconds and 14.1 seconds plus or minus 1.7 seconds, at the 90 percent confidence level.

68-0023

Muller, H. J. Fundamental considerations for the selection of the right waste container. *Staedtehygiene*, 19(6):121-124, June 1968.

The selection of the right waste container is important for the efficiency and economy of a waste-collecting service. Size and material are equally important. Since waste problems vary greatly from city to city, no one container can be universally adopted. Cities of medium size tend to use a 35-liter container, but there are arguments pro and con for any container chosen. The 35-liter container can hold half a week's waste from an average household. The user buys and maintains it, which relieves the collecting agency of repair and maintenance. Some cities use a 110-liter plastic container instead because of its light weight (empty 6.3 kg, full about 34 kg), its favorable price (35 DM), and its greater capacity. Since today's waste is becoming lighter and bulkier, the plastic container seems better adapted. However, plastic containers do flip over, roll onto the street, and become traffic hazards. In large cities (Munich, Hamburg, Frankfurt, etc.) the 1,100-liter container is being used. Experts agree that this larger container is an advance in efficient garbage collection, particularly since an efficient cleaning method has been found. A disinfectant is sprayed into the container after it has been emptied. Also, washing trucks are occasionally used to clean these containers. Paper bags are also more frequently used. Seventy-liter and 110- to 120-liter bags have been found very convenient. In selecting the right container, hygiene, adequate capacity, low personnel requirements, and economy are the main criteria to be considered. (Text in German)

68-0024

Paper sacks are replacing garbage cans. *Waste Trade Journal*, 64(16):56, Apr. 27, 1968.

Last year, residents of 14 European countries used 167 million disposable paper refuse sacks. Paper companies are offering 30-gal paper bags, usually two-ply thick, which sell for about 10 cents and are impregnated with chemicals to protect them from water, grease, and hungry animals. About 7,000 tons of kraft paper have gone into making the 20 million paper refuse sacks consumed in the United States this year. It is usually a municipal government that buys and distributes sacks after a local ordinance has made them official. Homeowners usually pay for the sacks as part of the water and sewage bill, or as a special charge. At present, half the bags sold go to industrial plants, restaurants, and hospitals, but it is predicted that homeowners will eventually be using 75 percent.

68-0025

Paper sacks in Florence. *Public Cleansing*, 58(3):134-135, Mar. 1968.

Florence has a population of 454,408 inhabitants and a total of 165,845 householders. At the present time refuse is disposed of at a tip 32 km away, and a two-shift collection system is employed, the first from 7:30 am to 1:30 pm, and the second from 1:00 pm to 8:00 pm. A total of 96,000 householders had been transferred to waterproof, two-ply cellulose chemically treated paper sacks of 25-liter capacity by the end of 1967. The standard team size consists of a driver and two collectors, each serving between 2,200 and 2,400 householders per day. Sacks are collected from the pavement, usually alongside doorways, and a clean sack is left in the place of each sack collected. About 68,000 sacks are required each week. The collection fleet is comprised of 33 OM (Tigre)-Bergomi with Norba bodies and 10 OM (Tigre)-Bergomi (Ochsner) or Fiat 642-Bergomi (Ochsner) vehicles.

68-0026

Polyethylene waste bag. *Sanitaer und Heizungstechnik*, 33(7):446, July 1968.

Containers for bandages and sanitary napkins can be replaced by the 'Alumasc' polyethylene bag. The bag, which can be collected with the regular waste, is especially suited for hospitals, plants, and factories where mainly women are employed. The wastes are thrown into the bag which, when full, is hermetically sealed simply by pushing a button. The sealing process takes 9 seconds. A red light comes on, and when it goes off, the bag is sealed and can be taken out of the frame. The frame has rollers and can be moved. The sealing unit is operated at 6/12 volts. The input voltage is 200/250 AC 50/Hz; the power consumption is 500 watts. (Text in German)

68-0027

Refuse in the bag. *Surveyor and Municipal Engineer*, 132(3987):30-32, Nov. 2, 1968.

Use of paper sacks in refuse collection is claimed to have the following advantages: hygienic disposal of organic wastes, efficient use of labor, dustless collection, versatility, noise reduction, and improvement of tip appearance. Holders and bags are somewhat more expensive in relation to metal bins,

Collection and Disposal-General

but the advantages are generally seen to outweigh this fact. Plastic sacks are sometimes used in conjunction with conventional metal cans as liners. No disadvantages at incinerators or tips have been noticed.

68-0028

Slatin, A. Self-standing refuse bag, new horizon for polyethylene. *Flexography*, 13 (10):22, 58-59, Oct. 1968.

'Self-standing' polyethylene refuse bags are already specified as acceptable to the municipal governments of several cities in both the United States and Canada. The bag can be contained within a can until collection time, but for actual collection, only the bag, filled and closed, is placed on the curb. This method of refuse collection has won the praises of both residents and sanitation men. It reduces pickup time, greatly improves sanitary conditions, and permits the use of open trucks, since the refuse is completely enclosed. The real success of this market depends on the acceptance and specification of polyethylene bags by municipal governments. The major effort to develop this market is being coordinated by the Society of the Plastics Industry in cooperation with its member companies, which have a proprietary interest in the application. The effort centers around the establishment of standards which will ensure high performance of the bags, eliminate field failures, build the market, and prevent abortive attempts. Under the current proposal, firms which manufacture the bags will be encouraged to obtain a 'seal of approval' from the National Sanitary Foundation. Use of the seal would certify that the bags meet the specifications of the National Sanitary Code. Garbage bags will be manufactured from polyethylene or ethylene copolymer resin having a density of 0.921 g per cu cm and tested in accordance with ASTM D-1505. The bags will have a minimum weight of 11 lb per 1,000 bags.

68-0029

Urge employing of plastic bins and continuous-loading vehicles. *Solid Wastes Management/Refuse Removal Journal*, 11(2):47, Feb. 1968.

A report prepared in London's Department of Public Health Engineering recommends the use of standardized plastic bins to improve the efficiency of collecting urban refuse. Other changes proposed include a minimum collection schedule of once a week, and the use of continuous-loading vehicles in all but the smallest authorities. The Continental dustless loading or disposable sack systems are considered the sole satisfactory ones for collecting refuse from small dwellings. Large buildings should use 1/4-cu-yd containers rather than batteries of bins. Interchangeable 12-cu-yd containers offer advantages in the case of large accumulations. Architects should be required to present plans showing satisfactory means of access for refuse collection.

68-0030

The affluent and the effluent. Waste management--problems and prospects. Chicago, Railway Systems & Management Association, 1968. 71 p.

A seminar, sponsored by the Railway Systems and Management Association, emphasized the role of rail haul in solid

waste disposal. Among the topics discussed were costs of solid waste disposal, refuse compaction and baling, transfer stations, rail-haul systems, land reclamation, public relations and pollution problems, and regional planning. Disposal systems in Chicago, San Francisco, and Philadelphia were discussed in relation to present or proposed rail haul of solid wastes and subsequent disposal on marginal, possibly reclaimable lands. Appendices list RSMA officers for 1968 to 1969, the constitution of the RSMA, and other RSMA publications.

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68-0031

Asbury, A. D. Solid waste--a plan for collection and disposal. Greenville, S.C., Greenville County Planning Commission, Nov. 1968. 33 p.

Solid waste handling processes in Greenville County were investigated. Problems caused by the proliferation of independent refuse-handling agencies are mentioned. Alternative methods of solid waste disposal are discussed with the determination that the sanitary landfill method is the most appropriate for Greenville County. Procedures for selecting and preparing landfill sites are outlined along with recommendations for operating nuisance-free landfills. The desirability of considering future recreation and open-space needs when evaluating landfill sites is discussed. Basic organizational recommendations are included in an effort to increase the efficiency of all refuse-handling systems throughout the country. Recommendations include closing over 200 illegal dump sites in the county. A network of disposal containers, located at strategic places throughout the county for the convenience of citizens in outlying areas, is suggested. Countywide landfill responsibility should be placed under the Greater Greenville Sanitation Commission. Scales should be installed at all existing and future landfills, and a minimum-fee system should be applied to all private collectors according to tonnage delivered at the landfill site. Commercial and industrial properties should be assessed according to the cubic yardage collected and the frequency of collection.

68-0032

Asbury, A. D. Existing collection and disposal operations in Greenville County. In *Solid waste--a plan for collection and disposal*. Greenville, S.C. Greenville County Planning Commission, Nov. 1968. p.5-14.

Because of the multiplicity of units engaged in the collection and disposal of solid waste, the total county picture is difficult to realize. An inventory of each service area is given to demonstrate the functional relationships that exist now. At least 16 private collectors operate within the county. Most private collectors use county-owned landfills for disposal at no cost. Yearly collection fees range from \$12 to \$30 for residential dwellings. Spartan Waste Control, Inc., collects more than half the yearly volume of the City of Greenville. Varying degrees of efficiency, economy, and reliability are found in the agencies now collecting solid waste in the county. With the possible exception of the City of Greenville

and the Town of Mauldin, most collection and disposal operations are operating at less than peak efficiency. The need for additional funds is obvious. Municipal and district budget priorities must be reassessed. Many of the citizens are aware of the annoyance factors generated by some of the landfills and dumps in the county. At least two dumps cause genuine health hazards. Rats, flies, litter, and dust are all side effects of less than properly controlled sanitary landfills. Lack of proper equipment and manpower are the chief factors responsible for the less than efficient operation of county landfills.

68-0033

Asbury, A. D. Selecting the best disposal method for Greenville County. In *Solid waste—a plan for collection and disposal*. Greenville, S.C., Greenville County Planning Commission, Nov. 1968. p.15-17.

Although open dumping is the least expensive of all methods, serious health hazards should rule out its usage. The practice of incineration is found mainly in the larger cities, and is justified only when it costs more to transport the wastes to a distant disposal site. Initial costs are high; over \$3 million would be required for an incinerator designed to serve the needs of Greenville County. Operating costs range from \$3 to \$6 per ton of refuse. Composting was not considered economical, either. As a result, a sanitary landfill was recommended. It was estimated that a 75-acre site would be required and that it would cost an initial \$175,000 and approximately \$1 per ton to operate.

68-0034

Asbury, A. D. Planning considerations. In *Solid waste—a plan for collection and disposal*. Greenville, S.C., Greenville County Planning Commission, Nov. 1968. p.19-26.

Selection of a sanitary landfill site involves consideration of topography, drainage, accessibility, availability of cover material, possibility of underground or surface water pollution, proximity to residential neighborhoods, and the ultimate reuse of the site. Using these criteria, a 5-year acquisition program was outlined for Greenville County. It was estimated that adequate facilities would cost approximately \$930,000.

68-0035

Beach city has enormous tree and plant waste. *Solid Wastes Management/Refuse Removal Journal*, 11(10):12, 76-77, Oct. 1968.

The presence of large hotels and private estates in Miami Beach, along with the effects of hurricanes and the need to keep the city spotless, place a large pressure on the city's sanitation department. The problem is met in part by provision of six neighborhood collection points for yard refuse and by the licensing of gardeners. In this way the formation of illegal piles of tree and plant waste is inhibited since inspectors can locate the guilty gardener by his license. The material from the local collection points is loaded into semi-trailers and sent to a disposal site.

68-0036

The big freeze. *Public Cleansing*, 58(3): 124-126, Mar. 1968.

In the Tynemouth/Wearside area of Great Britain, authorities have been trying to implement the recommendations of the Regional Refuse Disposal Committee. The Tynemouth group has already found a site and appointed consultants to prepare a scheme for an incinerator to handle the area's refuse. Other areas are also searching for suitable sites for an incinerator. In addition, steps are being taken to replace side-loading vehicles with rear-loading vehicles. Arrangements to implement the Civil Amenities Act include: designating refuse disposal works; controlling tips; cleansing depots and subdepots; equipping disposal centers with large capacity bulk containers; and providing paper sacks at a small charge. These arrangements, supplemented with a free service for the removal of bulky furniture and coupled with easy disposal of scrap vehicles, would appear to meet the demands of both the Civil Amenities Act and the Working Party report.

68-0037

Bjoerkman, A. V. Sanitation in Yugoslav cities. *American City*, 83(10):135-138, Oct. 1968.

The statistics presented on sanitation practices of Yugoslav cities are drawn partly from personal visits and partly from a report contributed to the Ninth International Congress on Public Cleansing held in Paris in 1967. The average daily refuse yield is about 2 lb per person. Nineteen municipalities used standard cans; none had a mixed stock, and eleven had altogether unsuitable receptacles. Only new multi-storied buildings in big Yugoslav cities have central refuse chutes, but due to a shortage of waste paper and lack of proper discipline on the part of the users, they have not been successful. The variety of refuse collection vehicles ranged from dustless trucks to horse-drawn vehicles. The latter still comprise 15 to 20 percent of the country's collection vehicles. Flushers can be seen in quite small towns but mechanical sweepers are only found in the big cities. Only in exceptional cases is incineration used. Sanitary fills should provide a temporary replacement for dumps, but future Yugoslavian refuse should be composted wherever possible. In the crowded city of Belgrade, all downtown refuse collection and most street cleaning is done at night. Fifty percent of all city streets are cleaned daily, with a minimum frequency of once every 3 weeks in the outer districts.

68-0038

Connolly, J. A., ed. Abstracts: selected patents on refuse handling facilities for buildings. *Public Health Service Publication No. 1793*. Washington, U.S. Government Printing Office, 1968. 320 p.

This volume contains 261 abstracts of patented equipment and methods for refuse handling in residential and office buildings; however, these inventions are not necessarily limited to use within buildings. Areas of interest include baling machines, bulk presses, refuse chutes, crushers, domestic and on-site compactors, grinders, sackholders, receptacles, refuse vehicles with detachable containers, and miscellaneous items. Equipment diagrams accompany many of the abstracts. Indices of contributing inventors and supporting

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companies are supplied. The collection is designed to aid investigators seeking original ideas for solid waste handling. The objectives of each invention, as well as the apparatus involved in its use, are presented.

68-0039

Cornelius, J. Solid waste management Kern County--1967. Berkeley, California Department of Public Health, 1968. 19 p.

The data gathered in Kern County by the State Department of Public Health during March 1967 as part of the California Solid Waste Planning Study is presented. Thirty-seven disposal sites were inspected and evaluated. Of special concern in Kern County was the air pollution resulting from open burning dumps as well as from the burning of agricultural and special wastes. Revision of the county's refuse management program from one based on open burning to a program based on sanitary landfills is needed.

68-0040

Cornelius, J. Solid waste regulations; solid waste production. In Solid waste management Kern County--1967. Berkeley, California Department of Public Health, 1968. p.1-11.

Kern County has adopted an ordinance which defines urban areas and regulates the collection of refuse, including the type and size of containers and collection rates. The Public Works Department has issued rules and regulations for all county dumps (see appendix). All incorporated cities in the county have ordinances regulating refuse collection and storage. Only one city ordinance regulates disposal of refuse. Some of the city ordinances are over 25 years old and in need of revision. In two of the cities the responsibility for solid waste disposal planning has not been assigned. An estimated 2.5 million tons of solid waste were produced in Kern County during 1967. These included 322,000 tons of municipal wastes (13 percent), 82,000 tons of industrial wastes (3 percent), and 2,117,000 tons of agricultural wastes (84 percent). A breakdown of the wastes by type is tabulated.

68-0041

Cornelius, J. Solid waste collection; solid waste disposal. In Solid waste management Kern County--1967. Berkeley, California Department of Public Health, 1968. p.12-18.

The cities of Bakersfield, Delano, Shafter, Tehachapi, and Wasco provide public refuse collection service. Five cities have mandatory household collection service. In all cases, household garbage and rubbish are combined. Information on the location, the areas served, and the owners of the 37 disposal sites is presented. Of the 37 sites evaluated, 20 are privately owned, nine are county owned, three are city owned, and five are located on Federal property. There are an estimated 25 unauthorized disposal sites which were not evaluated. Uncontrolled burning is practiced at 36 of the 37 disposal sites surveyed. Only three of the 37 sites had water at the site, and only 21 sites had firebreaks. The State Department of Public Health recognizes six categories of disposal sites: the uncontrolled burning dump; supervised dump with burning; modified sanitary landfill with

controlled burning; modified sanitary landfill; sanitary landfill; and special-use sites.

68-0042

Davis, R. W. Automated waste disposal systems are coming. Modern Hospital, 111(1):138, 140, July 1968.

Hospitals, with an estimated 12 lb of waste per bed per day, have had the choice of incinerating this waste, or having it trucked away. Incinerating waste involves manual charging and cleaning. Problems associated with this are: increasing labor costs, improper charging, incomplete burning, fly ash, and fire hazards. Removal of waste by truck costs more each year because trucking costs and the amount of waste to be removed continue to increase. A truly automated waste disposal system, the result of improvisations on the Friessen concept of hospital material processing and distribution, is now available. In each department in the hospital, waste material is placed in containers lined with disposable plastic bags. At scheduled periods the bagged waste is collected and removed, preferably by an automatic transportation system which conveys the waste and reprocessible items to a centralized decontamination room. All reusable items are sorted, automatically washed, and sterilized. All waste material is dropped into a waste-pulping unit, where it is mixed with chemically treated water to control odors and contamination. The resulting slurry is piped to a water press unit which extracts most of the water, leaving a semi-dry, homogeneous pulp. This pulp can be fed into a small incinerator which is both odorless and smokeless. Pathological waste can be fed manually at any time. A surge bin is used to hold the excess waste pulp until it can be incinerated. Such an automated incinerator system could pay for itself within 2 years.

68-0043

Engineering Foundation Research Conference; Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. 179 p.

The conference's program and preprints summarizing current solid waste projects are included under eight major subject areas: storage, collection, and transportation of solid wastes; sanitary landfill, incineration; composting; agricultural and industrial solid wastes; management and planning of solid waste systems; training; and special solid waste research.

68-0044

Fitzpatrick, J. V., and F. E. Dalton. Major urban areas. In The affluent and the effluent. Waste management--problems and prospects. Chicago. Railway Systems & Management Association, 1968. p.9-32.

The City of Chicago creates approximately 3 million tons of refuse annually and disposes of it through three city-owned incinerators, a city landfill, private incinerators, and private landfills. A new city ordinance will ban refuse burning in some 15,000 coal-fired apartment house boilers. It also calls for the upgrading of incinerators from an air pollution vantage point. Test results at Chicago incineration plants indicated that an average truckload of refuse includes: 70 percent paper products, wood, and rags; 11.7 percent dirt;

8.5 percent grass, 4.6 percent cans and metal; 4.2 percent bottles and glass; and only 1 percent garbage. The amount of garbage may vary up to 5 percent. A new service, the collection of bulky trash, will collect nearly 500,000 cu yd in 1968. A fourth incinerator is being built with a water wall to create steam for possible sale. Lack of landfill facilities and the high incineration costs of up to \$7 per ton have prompted the study of refuse compaction and rail haul. The compacted blocks could be used to reclaim recreational land in Lake Michigan, strip mines, and quarries. The Metropolitan Sanitary District of Greater Chicago utilizes a Zimpro unit to make fertilizer out of waste organic solids. The costs of disposing of activated sludge from sewage treatment plants by various methods are compared. Research is underway to prove that it is possible to take, in a safe manner, solutions of 3 percent solids and 97 percent water from digester tanks directly to farming fields. An experimental land reclamation system is illustrated.

68-0045

Flintoff, F. L. D. Refuse, scrap, and litter. *Journal of the Royal Society of Arts*, 116 (5145): 750-770, Aug. 1968.

In England and Wales, 14 million tons of house and trade refuse are collected by local authorities each year. The total cost is over £-60,000 annually. The nature of the refuse is changing rapidly and one of the main problems is the growing amount of bulky refuse such as automobiles, furniture, and appliances which must be disposed of. There are various proposals for elimination of storage and collection such as pneumatic conveyance of refuse and on-the-site incineration. The main methods, however, are controlled dumping, separation-incineration, and pulverization. Industrial waste is generally handled by industrial waste contractors. The problem of abandoned autos is being handled by legislation which provided a place for their disposal. Shredding is proving to be a method which can provide valuable scrap from old automobiles. Litter on the streets is being tackled with both legislation and public education, and with more litter bins. In the next 20 years the amount of refuse is expected to double. The number of men willing to take work as refuse collectors is not likely to increase, and provisions must start to be made now for handling these problems.

68-0046

Glasgow reaches its century. *Public Cleansing*, 58(10):545-546, Oct. 1968.

On the 100th anniversary of the formation of the Glasgow Cleansing Department, a booklet was published which tells the story of the evolution of the department. In 1868 the acreage of the city was 5,063; its population, 395,503; and the tonnage of refuse removed was 140,240. In 1967 the acreage was 39,725; the population, 979,798; and the tonnage of refuse received was 390,000. The department is equipped with the most modern plant and machinery, and has concerned itself with the welfare of its employees.

68-0047

Gray, A. C. Solid waste disposal at State University of New York, Albany Campus. M.S. Thesis, Rensselaer Polytechnic Institute, Troy, N.Y., Aug. 1968. p.1-3.

The primary purpose of this engineering thesis was to investigate the problem of refuse disposal on a university campus, specifically on the new campus of the State University of New York at Albany. The study includes, firstly, a nationwide survey of refuse disposal methods employed at approximately 60 American colleges and universities. This survey provides a showcase for any new methods or innovations in campus solid waste disposal. Secondly, an investigation of the methods of refuse collection and disposal on the Albany campus of the State University of New York was made to study the possibility of utilizing various methods of disposal, that is, the uses of the sewerage system, of sanitary landfill, of incineration, and of composting were thoroughly studied. Finally, the most efficient and economical method was selected for campus use. This was the utilization of the sewerage system and sanitary landfill.

68-0048

Hart, S. A. Solid wastes management in Germany; report of the U.S. Solid Wastes Study Team visit, June 25-July 8, 1967. *Public Health Service Publication No. 1812*. Washington, U.S. Government Printing Office, 1968. 18 p.

In mid-1967, a nine-member team of scientists and engineers, sponsored by the Federal Solid Wastes Program, went to Europe to investigate the domestic refuse management practices of Germany. The trip was designed to evaluate the possibilities of applying German technology to U.S. needs and to encourage mutual information exchange between the two countries. German domestic refuse is quite similar to American domestic refuse; however, it does contain slightly more ash, fewer cans and bottles, and less paper. Domestic collection is almost invariably handled by the municipal government. Collection is from the curbside, and containers are dumped into the collection vehicle by a mechanized lifting device. The dustless dumping originated because of the high ash content. Landfilling problems in Germany are similar to those in the United States. Many small, uncontrolled, open dumps are in use, and no sanitary landfills were observed. Composting is being practiced in nine locations in West Germany, but it is not a major refuse disposal process because the economics are not favorable. However, refuse incineration that produces steam or electricity is common. Although such incinerator plants are models of efficiency and good engineering, it still costs more to produce steam or electricity from refuse than from conventional fuels. The public works departments and their officials have a great deal of initiative and a relatively high degree of independence. The municipal officials, to whom the public works officials report, have a generous and approving attitude toward waste management costs.

68-0049

Henningson, Durham & Richardson, Inc. General. *In* Collection and disposal of solid waste for the Des Moines metropolitan area: a systems engineering approach to the overall problem of solid waste management; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.1(1-12)

Population and growth patterns are investigated. The study area encompasses 430 sq miles and includes 12 cities and

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parts of two counties. The topography, geology, and climate of the area are described. Des Moines, West Des Moines, and Urbandale provide municipal solid waste collection, while other sections are served by private haulers. Major disposal sites are described and located on maps. All but one are publicly owned. Land-use maps projected to 1990 are included. The present population is 288,000. It is expected to reach 361,000 by 1980, and 418,000 by 1990.

68-0050

Henningson, Durham & Richardson, Inc. Survey of solid wastes. In Collection and disposal of solid waste for the Des Moines metropolitan area; a systems engineering approach to the overall problem of solid waste management; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.2(1-43)

A study of the nature and magnitude of wastes from various commercial and industrial firms is presented. The firms that were surveyed deposited a total of 32 tons per day at public disposal sites. A table gives a breakdown of the types of firms and the quantities of wastes disposed of at public sites and on-site. Domestic waste other than kitchen waste is not presently collected. If all domestic waste was collected, 253,000 cu yd could be expected. The scrap market for junked automobiles and the auto salvage industry in the area are surveyed. Sections of the municipal code of Des Moines regarding automobile disposal are reviewed, and recommendations are made. The Dutch Elm disease problem in the area and its effect on removal of tree wastes is discussed. Treatment of packing house and rubber industry wastes is reviewed. Sewage solid waste disposal is discussed, and costs are given for various methods. A landfill survey was undertaken to determine quantity and characteristics of solid waste. Nine separate computer programs were developed to organize the information. A volume, weight, and vehicle analysis was carried out for wastes deposited at the landfill sites. The origin of landfill wastes is discussed. Present and future quantities of general, municipal, domestic, tree, commercial, and industrial waste are given. Annual waste quantities are expected to reach 1,500,000 cu yd or 783,000 tons by 1990.

68-0051

Henningson, Durham & Richardson, Inc. Collection of solid wastes. In Collection and disposal of solid waste for the Des Moines metropolitan area; a systems engineering approach to the overall problem of solid waste management; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.3(1-41)

Analysis and recommendations for existing collection systems is presented including data on records, routes, performance, new work rules, standards, routes and crew requirements, procedures for converting to new routes, equipment, and costs. Cost comparisons of the three current municipal systems and proposed systems for the collection of kitchen and all domestic waste are presented. Operation of the recommended Metropolitan Solid Waste Agency is described. Data are given on personnel, equipment requirements, and costs. An area-wide public collection system is recommended to replace the various municipal, contract, and private systems now being operated. The

system would provide weekly collection of all domestic waste, which is a change from the present practice of collecting only garbage. Public collection would not be offered to large multiple-family dwellings, nor to commercial or industrial locations. Private haulers should be licensed and regulated. The present Des Moines, West Des Moines, and Urbandale garbage collection systems are described.

68-0052

Henningson, Durham & Richardson, Inc. Disposal of solid wastes. In Collection and disposal of solid waste for the Des Moines metropolitan area; a systems engineering approach to the overall problem of solid waste management; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.4(1-34)

Incineration, composting, and landfilling are generally discussed. Sanitary landfill disposal is the best method for the study area. Two sanitary landfill locations, sufficient in size to dispose of the estimated study area waste for 1968 through 1987, are proposed. Existing disposal operations are described. These include sanitary and semi-sanitary landfills, open dumps, and open burning dumps. These sites should be closed when the new recommended sites go into operation, but interim improvements should be made, especially in the two Des Moines sites. Guidelines are given for improving these sites into model sanitary landfills. Improvements can be paid for by imposing a fee for the use of the site. Criteria and data used in selecting the new landfill sites are discussed, e.g. land cost, zoning, and driving time. Factors to be considered in developing the sites include the amount of land required, the initial development, and operation. These factors are discussed for the northeast and southwest areas of the total study area. Sanitary landfill cost estimates are examined.

68-0053

Henningson, Durham & Richardson, Inc. The metropolitan solid waste agency. In Collection and disposal of solid waste for the Des Moines metropolitan area; a systems engineering approach to the overall problem of solid waste management; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.5(1-10)

A Metropolitan Solid Waste Agency, responsible for the collection and disposal of all solid waste produced within the study area, is recommended. This agency would be governed by a board composed of elected representatives of the 14 cities, towns, and counties in the study area. The agency will provide collection services to all member municipalities on a contract basis of approximately \$10.80 per year per dwelling unit. The agency will also operate the two sanitary landfill sites. These will be open to anyone wishing to dispose of solid waste for the approximate fee of \$1.10 per ton. The initial capital expenditures of the agency will be financed by a revenue bond issue. Sufficient revenues are anticipated from the proposed collection and disposal fees to retire the bonds, as well as to provide the necessary maintenance, operating, and administrative costs of the agency. Uniform waste collection and disposal ordinances are recommended for adoption by all agency member communities. Model ordinances have been prepared, and are included in the report.

68-0054

Holbrook, J. A. Hospitals and the growing problem of waste disposal. *Hospitals*, 42(5): 57-60, Mar. 1968.

Hospital wastes may be classified as follows: garbage, which may be ground up and carried away in a sewer; wet waste incompatible with a sewer and difficult to burn; combustible wastes, paper, etc.; pathological and radioactive wastes, which require special treatment; and noncombustible waste such as glass and metals. Two of the major problems confronting hospitals are transportation of the wastes within the hospital, and final disposition. Movement within the hospital may be effected through pneumatic tubes throughout the hospital, accepting both bagged refuse and laundry, which may be separated at a central point. This might still require cart movement from the central collecting point. After separation of solid items, pulping of the wastes into a slurry may still cause problems if the added weight of the water clogs the system. The material must still be hauled to a central point outside the hospital for final disposal. Sewage disposal and incineration can both become more difficult due to increasingly stringent air and water pollution laws. Hauling wastes can be highly expensive. Hospitals will always have a problem disposing of pathologic waste, and an incinerator will probably be a necessity.

68-0055

Ingram, W. T., and F. P. Francia. Introduction. In *Quad-city solid wastes project; an interim report June 1, 1966 to May 31, 1967*. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.1(1-19).

The cities of Clifton, Passaic, and Paterson, and the township of Wayne in New Jersey commissioned this study to determine means for administering and operating a regionalized disposal system. Each municipality is examined separately, regarding both historical aspects and present conditions of housing, rate or degree of development and type of development, future population estimates, road system, land area, and topography. Refuse collection method and costs are discussed for each community. Maps, graphs, and tabulations include: portion of Passaic County with communities of Quad-city region; rate of change of decennial population 1930-1960; population predictions individually for each community; population data of the Quad-city region to 1980; refuse collection costs of Scavenger contracts for Clifton, Passaic, and Paterson; and unit costs of refuse collection of Quad-city communities.

68-0056

Ingram, W. T., and F. P. Francia. Assay programs. In *Quad-city solid wastes project; an interim report June 1, 1966 to May 31, 1967*. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.2(1-59).

A program to determine the quantity, the composition, and the physical and chemical characteristics of the wastes contributed by commercial-residential, industrial, and construction-demolition sources was undertaken. The weights of each packer truck contracted to pick up municipal refuse in the study area were obtained for one week in October, January, and May to determine municipal production. An analysis was carried out on one sample from a random load.

The laboratory sample was analyzed for moisture, volatiles, ash, carbon, nitrogen, and BTU value. No less than 20 percent of the industrial operations in a specific area of a given community were sampled by questionnaires and interviews to determine generation, collection, and disposal methods of the refuse. A survey was carried out to determine the amount and characteristics of the solid wastes generated in the study area by construction and demolition activities. Data were obtained through primary sources, demolition and construction contractors, and observation and calculations were made of the weights of typical structures, from one-family frame dwellings to industrial buildings. Street sweepings, junk autos, and debris collected from a regularly scheduled 'clean-up week' program are all estimated. Copious and detailed data from every phase of each operation are tabulated. Graphs and charts of these data are also provided.

68-0057

Ingram, W. T., and F. P. Francia. Meteorology. In *Quad-city solid wastes project; an interim report June 1, 1966 to May 31, 1967*. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.3(1-13).

Meteorologically, the entire Quad-city area is dominated by valley-slope configurations. The valley wind and slope winds characteristically exhibit an intermittent pattern in which steady-state conditions rarely persist for any length of time. The topography of the area includes a series of ridge lines and mountain chains which tend to isolate it from the coastal plains. In addition to spot checks of the area, field observations were conducted in October, November, and January using a mobile weather observation unit. The unit is taken to a station location where wind speed and direction is measured over a 15-minute period. No prime weather station existed in the area and readings from the closest station were neither consistent nor acceptable. The route followed is mapped, and data from a January survey are tabulated. Photographs taken on several dates from the same station are included. It is concluded that any stack emissions proposed which would emanate from the vicinity of the valley floor must be subjected to severe review from the standpoint of air cleaning.

68-0058

Ingram, W. T., and F. P. Francia. Influence of geology on site locations. In *Quad-city solid wastes project; an interim report June 1, 1966 to May 31, 1967*. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.4(1-23).

A study was made to present the geologic, topographic, and hydrologic factors occurring in northern New Jersey that are pertinent to the feasibility of locating solid waste treatment and disposal facilities without incurring chemical and bacterial pollution of ground and surface waters. The study area is almost equally divided between the Highlands Province and the Piedmont Plateau Province. The occurrence of surface waters in the study area is detailed, and the five water supply systems of the area are related to their watersheds. The occurrence of groundwater in the study area and a discussion of consolidated and unconsolidated formations are given. The close proximity of the study area to various surface and subsurface water supplies raises concern about contamination of such waters by runoff o.

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leachate from a landfill located within the area. It is recommended that any form of sanitary landfill be so located that it will never be in contact with groundwater or bedrock. It should be located in glacial deposits well above bedrock and the groundwater tables. A physiographic map including major glacial features of the Passaic River basin is included, as well as lithographic units of the Passaic County study area.

68-0059

Ingram, W. T., and F. P. Francia. Site investigation program. In Quad-city solid wastes project; an interim report June 1, 1966 to May 31, 1967. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.5(1-2).

The site investigation program included obtaining maps of the sites and making aerial surveys. Engineering data relating to major sewer, water, and electrical power utility lines were obtained. From this data, nine sites were investigated in detail. Inspections consisted of traversing the site and the immediately surrounding area. Topography, ingress and egress, roads or highways, land use, buffer zones, utilities, groundwater, and wind conditions were all examined. If a site was of particular interest, tax records were searched to identify the present owner, the assessed value, and the area. A plan of the candidate site was drawn up showing these features, and a short report on the site was included. The sites and details are not given here due to the sensitivity of this type of project.

68-0060

Ingram, W. T., and F. P. Francia. Status of the formation of a local regional authority. In Quad-city solid wastes project; an interim report June 1, 1966 to May 31, 1967. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.7(1-5).

The participating communities received a Federal grant from the Public Health Service to carry out this study. This study included developing means for construction, administration, and operation of a regionalized solid waste disposal establishment. A formal resolution was signed detailing the provisions of the grant and the role of the participating communities. An ad hoc committee composed of the city councils of each community was formed to draw up the incorporation articles of an autonomous body to be known as the 'Lower Passaic County Solid Wastes Management Authority.' This authority would have the rights to: acquire by any means personal or real property; negotiate contracts or agreements; sue or be sued; receive Federal or State aids or grants; and apportion costs and expenses based on valuation, population, and other factors. It is expected that when the professional staff completes its recommendation for a system of solid waste management acceptable to the four communities, the legal authority will follow shortly.

68-0061

Ingram, W. T., and F. P. Francia. Discussion of information. In Quad-city solid wastes project; an interim report June 1, 1966 to May 31, 1967. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.8(1-5).

High-temperature combustion has been examined and shown to produce a molten residue which granulates in water to

produce an inert material that is useful as a coarse sand or fine gravel. It is estimated that approximately 91 percent of the estimated 6.05 lb per day would be processible by high-temperature combustion, whereas only 72 percent would be processible by incineration. Specialized air pollution device requirements were deemed necessary for either process. Heat recovery from either process is probable. Long-haul transport of the residue to sites which satisfy sanitary landfill criteria might offer an interim solution. Composting seems to have little potential of meeting the requirements of urban needs in a metropolitan locale. Operating costs are described as difficult to establish, but data ranges from \$2.60 to \$6.67 per ton for incineration, \$3.00 to \$3.40 for high-temperature combustion, \$3.00 to \$4.00 for composting, and for haul landfill \$4.00 to \$5.00 per ton. A study considering each of these methods in detail including the supporting technology and air-cleaning devices necessary, is now recommended.

68-0062

Ingram, W. T., and F. P. Francia. Future work. In Quad-city solid wastes project; an interim report June 1, 1966 to May 31, 1967. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.9.

In August the completion of a fourth assay of residential refuse is planned under the grant to provide data on the variations due to seasonal activity. The composition of industrial waste, including a study of a composite if necessary, will be investigated. A detailed engineering investigation will provide for the construction of a demonstration unit, after a demonstration grant application has been prepared. Action to form the regional authority must also be undertaken.

68-0063

Isaacman, T. Wesley saves money by 'throwing away meals.' *Modern Hospital*, 110(6):106-107, June 1968.

Chicago Wesley Memorial Hospital is saving \$30,000 annually by using disposable trays, utensils, and containers that are thrown away with the garbage. The hospital has been using compactor units to absorb its debris. These are sealed 33-cu-ft boxes which contain built-in grinders and automatic germicidal sprays. Three times weekly, a commercial firm backs a compactor into one of the hospital's truck loading bays. Sanitation personnel then dump all the hospital's solid wastes, including garbage, junk, paper, and old furniture, into the box, which then grinds the debris and squeezes it into as small a bundle as possible. When the commercial firm brings the next empty compactor, it carts away the full box. The incinerator is still used, but no longer overheats as was its custom before the compactor plan was adopted.

68-0064

Joint destructor plant scheme. *Waste Trade World*, 112(7):4, Feb. 17, 1968.

A plan for a joint refuse disposal scheme is to be considered by three local councils in Great Britain. They plan to purchase more sophisticated equipment for separating paper, rags, and metals. The urban council considered three

alternatives to the joint scheme with the two rural councils: use of a site outside the urban district which would involve lengthy distances; a refuse plant for the urban council alone which would cost about £-35,000; or disposal within the urban area which would mean using valuable land.

68-0065

Ludwig, H. F., and R. J. Black. Report on the solid waste problem. Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, 94(SA 2):355-370, Apr. 1968.

The need for investigation in all areas of solid wastes problems is described, and management of these problems is discussed. Technologies that could be applied to solving the problems are described in detail for: incineration; composting; sanitary landfill; grinding for sewer discharge; salvage and reclamation; reduction in solid waste quantity; collection and hauling systems; and air, water, and land resources management. Recommendations include: alerting decision-making public administrators to the problem; recognition through a national conference; full implementation of the Solid Waste Disposal Act; study of salvage markets; development of new collection and disposal methods; reducing air and water pollution; and review of current legislation.

68-0066

Mead and Hunt, Inc. Western Jefferson County solid waste disposal study. Madison, Wis., Feb. 1968. 21 p.

A feasibility study was conducted for five western Jefferson County communities. They wished to jointly operate a centrally located refuse disposal site and an associated collection system. The information considered most pertinent to the study was geographical location, population, land use, quantities of refuse, present refuse collection practice, and present refuse disposal practice. The major refuse problems presently facing most of the communities are the high costs of operating properly maintained disposal sites, smoke and odor nuisance, and the scarcity of available land for the disposal of refuse. A sanitary landfill disposal operation, centrally located and jointly owned, has been shown to be the most economical disposal operation. A jointly-owned collection system of container trains, used in conjunction with transfer packer trucks, has appeared to be the most economical of investigated collection systems. Weekly collection of mixed refuse appears to be a reasonable frequency. The annual cost of the proposed collection and disposal system will be approximately \$132,000 or \$6.33 per capita. If the surrounding ten townships are included as customers, the communities' share of the annual cost will be only \$109,000 or \$5.22 per capita. The initial cost of the system will be \$346,100 or \$472,800 if the surrounding townships are included. The refuse disposal system should be designed to handle the quantity of refuse generated through the year 2000.

68-0067

Moore, F. J., L. Landy, M. O. Aibi, D. M. Copenhagen, and D. M. Kerr. The rail handling of municipal solid waste. In *The affluent and the effluent. Waste management—problems and prospects*. Chicago, Railway Systems & Management Association, 1968, p.53-71.

Railroads are suggested as the most efficient, economical, and permanent way of connecting the refuse generating area and a final, esthetically appropriate, sanitary landfill operation. A rail system consists of three basic units: a truck-to-rail-transfer processing station; rail cars for handling the refuse on the railroad; and a sanitary landfill operation. A rail system can dispose of all manner of solid waste such as demolition, industrial, junked automobiles, and trees. A plan for two shredders would increase the capacity per transfer station to 1,120 tons per day, allowing 8 hr per day for maintenance. The necessity of a well-planned public relations program and a strict marketing approach to system analysis is emphasized. A refuse press is described which produces 500 tons per 8-hr shift and requires a seven-man operation at the transfer station. The container system and high compression baling process, used for rail haul of solid wastes from the San Francisco area for landfill disposal, is outlined. The system serving Philadelphia and adjacent counties includes transfer stations, shredding and baling operations, and landfill operations. A 6,000-ton barge will also be operated for ocean disposal of sludge and industrial liquid waste.

68-0068

Orth, H. City cleansing. *Verein Deutscher Ingenieure Zeitschrift*, 110(14):599-602, May 1968.

The present state of the art of city cleansing is reviewed. For cleaning streets and roads, automatic sweepers are used. Sidewalks are cleaned manually. A sludge suction truck, operating according to the vacuum principle, is used to clean gutters. Canals are cleaned with a high-pressure rinsing pump, whose three-piston pump produces a water pressure of 80 to 120 atm. The hose, 120 m long, is attached to a spray nozzle and can be lowered into the canal, and a hydraulic winch is used to bring the hose back. Gasoline dischargers are cleaned by trucks which suck fluids according to the vacuum principle. Metal trash cans are increasingly being replaced by polyethylene containers. Waste paper bags are now being used to care for excess wastes. Large containers in agreement with design standard DIN 2166 are favored in apartment houses, schools, and hospitals. The containers are either taken away full and empty ones left, or they are emptied into trucks. Large factories use the 4,400-liter and 6,000-liter containers. (Text in German)

68-0069

Refuse collection in Arkansas. *Public Works*, 99(5):68, May 1968.

A survey of refuse collection and disposal in Arkansas municipalities was recently made by the Arkansas Municipal League. The returns were segregated by population groups. All but one community either utilized municipal collection or licensed private contractors. Disposal by trench fill, open dumping, and burning was reported. In 22 communities with populations ranging from 1,000 to 2,000, 11 utilized municipal collection, 10 utilized private contractors, and one left the job to the individual. Disposal by trench fill was reported by two places; all the others used open dump and/or burning. In the largest population group, consisting of cities of 20,000 or over, municipal collection is provided by seven cities, with one being served by a private contractor; three of this group of cities use trench fill disposal and one reports closed burning.

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68-0070

Refuse disposal study and plan. Prepared for the Central Naugatuck Valley Regional Planning Agency, Waterbury, Conn. Boston, Metcalf & Eddy, Engineers-Planners, Sept. 1968, 73 p.

This report, financed in part through an urban planning grant, is the first in a three-phase study covering waste disposal by the Central Naugatuck Valley Regional Planning Agency, Connecticut. It describes the present refuse disposal system and laws of each of the 13 municipalities in the area. Included are the volumes per capita of refuse now produced and the costs of handling it. These figures are used to make projections of the areas' needs up to 2010, the date that is designated as the area saturation time. Several plans to handle the increased quantities of refuse are propounded, and of these, one is selected as the most practical. It first involves exhausting the present landfill sites, and then converting to a subregional plan in which neighboring municipalities share new facilities. Many of the more important considerations in the text are also tabulated by town. These included inventory of present facilities, refuse quantities per capita per day, inventory of present collection practices, comparative costs, estimates of population growth, and evaluation of proposed disposal sites. There are also several maps showing the locations of the present sites, proposed sites, and the proposed subregional arrangement.

68-0071

Refuse disposal study and plan. Present disposal practices. Prepared for the Central Naugatuck Valley Regional Planning Agency, Waterbury, Conn. Boston, Metcalf & Eddy, Engineers-Planners, Sept. 1968, p.16-37.

The existing disposal facilities in the Central Naugatuck Valley are listed according to the closest town. A total of 20 disposal facilities serve the 13 towns in the area. Eleven of these are landfills, three are dumps, two are piggeries, and one is an incinerator. Types and amounts of refuse received at these facilities are broken down and tabulated. The totals of these figures indicate 115,170 tons of refuse was disposed at municipal facilities in the area in 1966. Another 9,620 tons was disposed of privately. This is an average of 5.1 lb per person per day for all types of refuse. Industrial waste amounted to 48,500 tons or 25 percent of the total. There are three municipal collection systems operating in the larger cities, three municipal contract services, and some 30 major private collectors operating in the smaller towns. There are also numerous small private collectors operating in the towns. Two municipalities have transfer systems. The various parameters of the larger collection systems are listed. All municipal and contract services are paid for by tax monies, except for the town of Cheshire, which charges industries \$25 monthly. Private collectors charge homeowners \$1.50 to \$2.50 monthly. The transfer systems cost from \$10 to \$20 per ton. The system costs for the various towns are compared in bar charts. Capital costs are difficult to consider since the communities do not amortize the costs, and facilities are frequently used for other operations. Industrial liquid wastes are accepted at landfills or discharged into rivers. Both of these are considered bad practices. Junked automobiles, septic tank pumpings, and bulking wastes are other disposal problems which are not handled properly.

68-0072

Refuse disposal study and plan. Basic planning Criteria. Prepared for the Central Naugatuck Valley Regional Planning Agency, Waterbury, Conn. Boston, Metcalf & Eddy, Engineers-Planners, Sept. 1968, p.38-45.

Estimates of future refuse quantities are a necessary factor in planning future collection and disposal systems for the region. These are based on past experience in the region and in some cases, outside sources. Estimates are made on future service areas; projections are made of population, commercial, and industrial growth. The development of contractor and private disposal facilities is considered, too. Charts projecting to the year 20XX (a projected year for full development of the general plan around 2010) are presented showing population growth by towns, and refuse quantities per capita per day for each town. The general ratios of these variables are not expected to change over the time period, but the proportion of refuse handled by municipal facilities is expected to increase over the contractor and private facilities. Finally, a list of recommended standards and basic practices covering incineration, landfills, and transfer stations, along with refuse haul distances for various types of transportation, is given.

68-0073

Refuse disposal study and plan. Adequacy. Prepared for the Central Naugatuck Valley Regional Planning Agency, Waterbury, Conn. Boston, Metcalf & Eddy, Engineers-Planners, Sept. 1968, p.46-51.

Existing refuse systems are evaluated with respect to their ability to provide satisfactory service under anticipated future conditions. To evaluate the existing disposal systems, projections of refuse quantities to be delivered to municipal facilities is compared by decades up to 2000 with the volumes remaining in the landfills and dumps, upgrading where necessary for sanitary operation. The capacity of the one incinerator is also considered according to estimated future quantities. The capacities of these disposal facilities are also graphically represented in comparison with the projected refuse quantity for the area. The intersection of these curves is the year when the existing facility becomes saturated. For most areas, this occurs before 1990. The incinerator will be operating at full capacity by 1970, however, with three-shift operation and no major down periods, its use can be extended until 1985. Only one of the contract disposal facilities is expected to remain in use over the entire period. Piggeries are expected to be discontinued because they are uneconomical. With normal maintenance and replacement, the collection systems of all the municipalities appear to be adequate, except that at Naugatuck, which will soon require additional trucks. If the transfer stations are retained, they should be improved.

68-0074

Refuse disposal study and plan. Alternate plans. Prepared for the Central Naugatuck Valley Regional Planning Agency, Waterbury, Conn. Boston, Metcalf & Eddy, Engineers-Planners, Sept. 1968, p.52-65.

All municipalities within the region will need to take substantive action by 1990 in order to maintain adequate

refuse services within their areas, however, the dates for each municipality will vary according to their present setup. The General Plan of Regional Development of 1964 has designated areas for growth of industries and residences until 2010. Within this plan, 31 sites for disposal areas were selected. These are located on a map and described as to accessibility, size, cost, and soil condition. Three alternate plans are put forward to handle the refuse projected until 2010: each municipality will retain full responsibility for refuse collection and disposal; all refuse in the region will be delivered to a large central disposal site; and transfer stations will be used where long hauls are necessary; nearby towns will be involved on a subregional basis. By 2010 most refuse will probably have to be incinerated, and these units are more economical when larger. Thus, the plan allows for the exhaustion of present landfills and gradual mergers to use incinerators as they are built. Although different towns would benefit from different plans, a comparison of the entire area shows one plan to be the most economical. Special wastes, such as automobiles and chemicals, would be handled separately. Automobiles might be shredded on a special machine purchased for the area. Sewage sludge cake can be handled like refuse.

68-0075

Refuse disposal study and plan. Recommended plan. Prepared for the Central Naugatuck Valley Regional Planning Agency, Waterbury, Conn. Boston, Metcalf & Eddy, Engineers-Planners, Sept. 1968, p.66-73.

Of the various described plans for refuse disposal and collection, the subregional plan is the most advantageous in cost, and it possesses substantial advantages such as flexibility and the probability that it will be the most acceptable of all considered. Implementation of this plan is described in detail and summarized in two charts. It involves the formation of four subregions wherein two towns participate in one disposal facility, and it recommends new sanitary landfill sites for the other five towns in the area. In each case, the condition of the present facility was examined so that maximum use of it might be made before opening a new site. Several choices for the management of the subregional facilities are presented, and the legal aspects are reviewed. Municipal refuse collection systems are generally not recommended for the smaller towns, but where they are proposed, it is suggested that each town operate its own. This plan carries the region into 1990, after which an alternate subregional plan can be put into effect serving the area until the saturation year 20XX (about 2010).

68-0076

Researchers try polluting pollution. Engineering News-Record, 181(7):16, Aug. 15, 1968.

Environmental engineers at the University of Notre Dame have discovered a way of cleaning up scum-covered water by mixing fly ash with it. U.S. power plants produce and trap fly ash in their smokestacks at the rate of 30 million tons per year. Only about 2½ percent of this amount is utilized, and utilities spend an average of \$2 per ton to get rid of it. At Penn State, researchers have found that 1 part acid drainage, and 6 parts sewage plant effluent will sweeten a polluted stream, reduce the acidity of the mine drainage water, and remove troublesome phosphates and iron salts. Seattle is going to mix beach sand with wet, digested sewage sludge,

and then use it to reclaim four acres of tideland for a park.

68-0077

Robert and Company Associates, and Reynolds, Smith, and Hills. Engineering study; solid wastes disposal; City of Tampa, and Hillsborough County, 1968. 81 p.

Solid waste problems have developed in direct proportion to the population growth of Hillsborough County, which includes the corporate municipalities of Tampa, Plant City, and Temple Terrace. The county is presently disposing of more than 372 tons per day of refuse, 230 tons of which are generated in county areas and the remainder in Tampa. The location of suitable new landfill areas has been a problem. The methods and equipment employed to transport refuse to existing landfills prior to the construction of a municipal incinerator in Tampa are reviewed. Information is presented about the type and quantity of refuse generated in various areas of the county, including the quantity collected by franchise and private operators. The resulting load to each disposal area is tabulated according to measured 1967 and projected 1985 refuse generation. Disposal limits and load centers are developed for six basic refuse generation areas and three methods of disposal (sanitary landfills, incineration, and composting) are analyzed as to their effectiveness and cost. Transfer stations are considered as an auxiliary facility for use in combination with one or more of the methods. The solid waste program developed for each area is described. The recommendations cover new landfill sites and/or mechanical refuse disposal plants, a fourth unit for the Tampa incinerator, and improvements in existing rural landfills.

68-0078

Robert and Company Associates, and Reynolds, Smith, and Hills. Existing collection and disposal methods. In Engineering study; solid wastes disposal; City of Tampa, and Hillsborough County, 1968. p.III(1-9).

Refuse collection in Hillsborough County is accomplished independently by the three corporate municipalities (Tampa, Temple Terrace, and Plant City), by franchise operators in county areas, and by private companies and individuals who collect and transport their own refuse to disposal areas. There are wide variations in collection methods primarily related to the type and size of the collection organization and equipment and the controls exerted thereon. Refuse disposal is provided by Tampa and Hillsborough County. Temple Terrace hauls refuse to a county landfill, as does Plant City. In the interim period between the shut down of its landfill operations and the start up of a new incinerator, Tampa used landfills jointly with the county. There are presently nine landfills strategically located throughout the county, each operating on a daily schedule. Except for cooperative refuse disposal with Tampa, the county charges for all refuse received at the landfills.

68-0079

Robert and Company Associates, and Reynolds, Smith, and Hills. Population and refuse quantities. In Engineering study; solid wastes disposal; City of Tampa, and Hillsborough County, 1968. p.IV(1-13).

The estimated 1967 population of Hillsborough County is 448,173. Of this total population, 299,968 individuals live in

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the City of Tampa and 148,205 in unincorporated areas of the county. By 1985 the total population of the county will reach 709,930, the population of Tampa will be 341,430, and that of the unincorporated area, 368,500. As determined by a comprehensive weighing program, Hillsborough County (exclusive of Tampa) now generates 437,730 lb per day of refuse. Tampa generates over 6 million lb per week. The present per capita refuse generation in the county (exclusive of Tampa) is 4.08 lb per day. The present per capita refuse generation in Tampa is also about 4.08 lb per day. By 1985 the per capita refuse generated will reach 4.58 lb per day for the county (exclusive of Tampa) and 4.5 lb per day for Tampa.

68-0080

Robert and Company Associates, and Reynolds, Smith, and Hills. Analysis of collection and disposal methods. In Engineering study: solid wastes disposal; City of Tampa, and Hillsborough County, 1968. p.V(1-37).

Disposal limits and load centers were developed for six basic refuse generation areas of Hillsborough County, Florida. Sanitary landfills, incineration, and composting were analyzed as to effectiveness and cost. Transfer stations were considered as an auxiliary facility for use in combination with one or more of the three disposal methods. The operation of the nine existing landfills was found to be adversely affected by faulty bulldozers and the lack of standby equipment, which necessitated the rerouting of refuse to more distant fills. The bulldozers should be replaced by a compactor to obtain greater compression ratio of the refuse. To make the landfill operations totally self-supporting through disposal charges, the refuse received must be weighed on automatic scales. These improvements would result in processing costs of \$1.00 to \$2.00 per ton. The annual cost of the rotary kiln incinerator in Tampa is \$686,590. Based on 500 tons per day, refuse costs per year equal \$3.86 per ton, exclusive of the sale of salvaged material. Composting costs for a plant with a capacity of 117 to 350 tons per day are estimated at \$4.76 to \$7.83 per ton. The sale of salvaged material would, however, reduce composting costs to \$2.42 per incoming ton. Estimated costs of handling refuse at a typical transfer station are \$1.38 per ton.

68-0081

Robert and Company Associates, and Reynolds, Smith, and Hills. Proposed immediate and long range solid wastes. In Engineering study: solid wastes disposal; City of Tampa, and Hillsborough County, 1968. p.VI(1-12).

Based on cost analyses of disposal methods, solid waste disposal programs were developed for six areas in the City of Tampa and Hillsborough County. The use of sanitary landfills or a transfer station hauling to the Tampa incinerator is shown to be cheaper than constructing mechanical refuse plants of either the incinerator or composting type. It is suggested that existing landfills in rural areas not only be maintained, but upgraded. A new landfill site is recommended for a combined city-county refuse generation area. In this area, a transfer station combined with final disposal by sanitary landfill would be less expensive than final disposal by the city incinerator, provided the landfill site is near the station. A transfer station is also an alternate

choice for another area where landfill sites are difficult to acquire. If the transfer stations are not combined with sanitary landfills, the Tampa incinerator will require immediate expansion by the addition of a fourth unit. Uniform disposal charges should be adopted for all disposal facilities.

68-0082

Rogers, P. A., and D. R. Andre. Status of solid waste management; California solid waste planning study; interim report. v.1. Sacramento, California State Department of Public Health, Sept. 1968.

The interim report of a study performed by the California State Department of Public Health under a U.S. Public Health Service Grant contains findings on an extensive survey of California on solid waste. A summary presents the major findings in each of the following categories: production, administration and control, collection, disposal, planning and environmental effects. Appendices contain: maps of disposal sites for the entire State and for each county with related data by county, a summary of state laws, and regulations related to solid wastes, and the definition of the manufacturing section of the Standard Industrial Classification, used as a basis for a study on industrial processing of wastes.

68-0083

Sanitary refuse disposal. Modern Hospital, 11 (3):179, Sept. 1968.

A new device packs disposables into enclosed containers. A 350-bed hospital is experimenting with a new technique in sanitation, refuse compaction, storage, and disposal. It is claimed that the new system replaced four of the six 10-yd refuse containers previously in service and drastically reduced burning loads in its gas-fired, 4-burner incinerator. The new compaction system, called The Power Mite, is a small hydraulic refuse stationary packer which can be hand loaded from ground level, from a dock, or placed under a trash chute. Depending on the density of the material, packing ratios of from 3 to 6 to 1 are achieved. When the refuse container is full, a truck-mounted handling unit picks up, hauls, empties, returns, and locks the container to the unit. One man and one truck do all of the work. Existing refuse containers can be modified to work with the new unit at a modest cost. The many advantages of the new unit are outlined and presented.

68-0084

Sheaffer, J. R. Dimensions and trends in solid wastes. In The affluent and the effluent. Waste management—problems and prospects. Chicago, Railway Systems & Management Association, 1968. p.35-38.

Various dimensions of the solid waste problem are related to the large quantities of industrial wastes, and to waterway pollution, building demolition, air pollution abatement, and agricultural wastes. To provide an order of magnitude for the solid waste disposal problem, an estimate is presented of the volume of solid wastes produced in Cook County, Illinois, in 1966. The concept that solid wastes are resources is explored.

Examples are cited of recycling solid wastes such as paper and metal, utilizing sludge as fertilizer, and reclaiming land in the form of sculpturing. Several trends in solid waste disposal efforts lead to considering the establishment of regional materials reprocessing centers. The efficiency of the railroad industry regarding the solution of solid wastes disposal problem is examined. The concept of large regional material reprocessing centers will require rapid, high volume, long distance transport of solid wastes.

68-0085

State Department of Health, Richmond, Virginia. The sanitary disposal of refuse. Virginia Health Bulletin, 20(10):1-16, Feb. 1968.

Growth of population and continued use of present merchandising methods only mean more refuse to handle. Already refuse handling represents local government's third largest expenditure of funds. Improperly handled domestic refuse breeds a media for vectors and fire hazards. Three aspects of the problem exist: storage, collection, and disposal. Storage standards are established by local ordinances. Collection is accomplished by a private collector, a municipally operated system, and/or contract. Sanitary landfills and incinerators represent the two most acceptable methods of disposal. Salvaging and composting have strong potential for future use. The Virginia State Health Department requires all cities, towns, and counties to file their disposal plans for the next decade, surveys all refuse operations on a 20-year basis (financed by a U.S. Planning Grant), and acts as a consultant on a Virginia Beach demonstration project to create an amphitheater and coasting ramp from refuse. It has also established location, planning, and operating criteria for landfills and incinerators. These requirements are listed in detail.

68-0086

Study of refuse disposal methods in Connecticut. Hartford, Connecticut State Department of Health, Dec. 1968. 41 p.

In compliance with Special Act 375, the Connecticut State Department of Health organized a study group consisting of five committees, each to investigate a specific phase of refuse disposal methods. The committees investigated: types and quantities of domestic and bulky wastes; automobiles and industrial wastes; the problem of fly ash and industrial waste disposal; methods of disposal; available land for refuse disposal; collection and transportation of refuse. It formulated new legislation and amendments to existing laws and regulations, especially such items needed to allow implementation of other committees. Sanitary disposal of solid wastes and certain liquid wastes is at present a serious problem in Connecticut due to the increasing population and the continuing loss of suitable land area. The economics of constructing and operating a disposal facility calls for regional and long range planning. Alternative and recommended approaches are discussed. Excerpts from committee reports and supporting tables and charts are included.

68-0087

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 68 p.

A comprehensive study of the solid waste disposal practices in a small rural county in Kentucky was made. The wastes are divided into residential, commercial and institutional, industrial, and agricultural. The special problem wastes such as abandoned autos are also considered. The two public disposal sites in the county are discussed in detail as is the variety of collection services available. A projection of future waste generation is made, and an appendix covers the legal aspects of the waste problem. Maps included show the population distribution of the county, as well as the abandoned autos and the roadside dumps. The routes of the waste collectors in the county are also shown. Tables summarize the data in the text including the generation and disposal of industrial and residential wastes. A series of 32 photographs illustrate the disposal problems of the county.

68-0088

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Study procedure. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.10-11.

The study of the solid waste practices in Bullitt County consisted of three general phases: a preliminary survey involving several visits to the county by the Project Officer and Director to gather information necessary for the planning of the field survey; an aerial survey of the entire county to locate the open dumps, junked automobiles, and small indiscriminate dumping areas; and finally, a comprehensive field survey. The survey included visits to all types of solid waste sources, evaluation of residential storage, interviews with industrial personnel, collection firms, and auto parts dealers, and visits to open dumps and dumping areas.

68-0089

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Residential solid wastes. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.18-24.

The residential solid waste generated in Bullitt County was estimated at 133 tons per week based on 1.75 lb per person per day. Of this, 94.4 tons is generated outside of the three incorporated cities. A survey of the storage practices showed open burning to be the most common deficiency. Uncovered containers and littered areas were the next most common problems in the whole county. The cities are served by private collection firms which are optional to the homeowner, but services are only available to a few of the more populated areas of the rest of the county. Residents in the outlying areas either dispose of their waste on their properties or haul it to a dump. The use of home garbage grinders is negligible.

68-0090

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Commercial and institutional solid wastes. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.25-30.

To estimate the total quantity of solid waste and its handling by the 250 businesses in Bullitt County, a cross section of 94 was selected and surveyed. Of these, 32 were institutional

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buildings such as schools, churches, and county buildings. From this survey, it was estimated that all commercial establishments generated 41 tons per week of solid waste. All institutional facilities generated 15 tons per week. A majority of the businesses use 55-gal drums for storage, while the schools use 20-gal trash cans. More than half of the businesses use collection services ranging from once a month to daily, and 69 percent of all businesses burn all or part of their wastes. Complaints are often received about these practices. Tables are included showing the amount and type of waste produced by each business surveyed and the disposal variables encountered.

68-0091

Technical services report on the management solid wastes in Bullitt County, Kentucky. Industrial solid wastes. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.31-34.

Of the 14 larger industrial companies in the county, 11 were visited and interviewed. Those surveyed produce 7 tons per week of waste, excluding such materials as sawdust, dirt, and concrete. Most of the waste is burned, and the rest dumped off site. Seven of the 11 had acceptable storage facilities, and three used commercial collection companies. The county has no major problem with industrial wastes where companies took care of them adequately.

68-0092

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Agricultural solid wastes. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.35.

Although the farm population of Bullitt County in 1964 was 20 percent of the total county population, the amount of solid waste generated in farming activities did not influence the collection and disposal problems of the non-farm population. All farm wastes are either reutilized or disposed of on the farm.

68-0093

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Special solid wastes. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.36-38.

Special solid wastes include abandoned automobiles, septic tank solids, dead animals, and hazardous materials. An aerial survey located at least 900 abandoned automobiles outside of the five commercial auto-part companies which have an estimated 2,500 junked cars. One septic tank pumping company in the county lagoons the solids on a farm in the center of the county. An estimated 90 small dead animals are picked up by commercial haulers in the three cities of the county, and the approximately 100 animals killed on the county roads are picked up by the highway maintenance crew or by local residents. Explosions and fires at unauthorized dumps have indicated the dumping of hazardous materials. This dumping is probably done by industries located outside the county.

68-0094

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Collection services. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.39-44.

The 11 collection firms in the county are thoroughly outlined and a map is provided showing their routes. They range in size from a company which serves an estimated 1,000 homes in a franchised area down to an individual who collects from eight homes in his spare time in an area served by three other collectors. Frequency of collection varies from twice per week to twice per month. The routes cover the densely populated areas only and they frequently overlap. None of the 11 collection systems were considered to be satisfactory, due to lack of suitable collection equipment, operating records, and safety.

68-0095

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Disposal sites. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.45-60.

Both the Bullitt County dump and the Smith Farm Dump, the two public dumps serving the county, were judged unsatisfactory by the survey team due to lack of compaction and daily cover, presence of insects and rodents, odors, and fire hazards. The county dump is simply a disposal area open all the time and accepting everything except septic solids and hazardous materials with no records kept as to users or amounts. The Smith Farm charges by the load and has contracts with some out-of-county companies. It is divided into separate areas for household and industrial wastes and also for burnables and nonburnables. Salvaging is permitted in return for bulldozing services. Three dumps in the county have been ordered closed and are now partly covered by dirt. Their condition is also unsatisfactory. The aerial survey located 207 roadside dumping areas indicating proper disposal sites are not convenient enough.

68-0096

Technical services report on the management of solid wastes in Bullitt County, Kentucky. Solid waste generation project. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.61-63.

The county population in 1967 was estimated at 21,750 with an average waste generation of 1.75 lb per day or a total production of 133 tons per week. The population is projected to be 38,250 in 1987, generating 350 tons of solid waste per week. No attempt was made to forecast the industrial or agricultural development of the county.

68-0097

A technical services report; comprehensive solid waste study, Johnson City, Tennessee. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 63 p.

A detailed description of the current waste collection in

Johnson City is given. This study includes the on site storage of wastes, their collection from residences and commercial establishments, the transfer system, and their ultimate disposal sites. The specific areas of the system that need improvement include: fly control, labor productivity, and commercial and industrial waste collection. A method of cost allocation is suggested. The equipment force is studied with suggestions for more efficient use as well as a study of the dump and composting plant. The inadequacies of the city's ordinances covering solid wastes are pointed out. The appendices include specific cost data to back up the recommendations for system changes in the text. There is also a detailed breakdown of residential waste by material types and amounts for different income residences. A group of sample forms are included to implement the surveys suggested in the text.

68-0098

Waste collection and disposal in Scarsdale. Public Works, 99(4):165, Apr. 1968.

The Sanitation Department of Scarsdale, N.Y. provides three collections per week for combustible refuse and one collection per week for noncombustibles such as yard and garden materials and household furnishings. Combustible refuse is incinerated, while leaves, brush, etc. are disposed of at the brush disposal area. During the year, the Village Highway Department used this area for disposal of 491 loads of leaves, 446 loads of logs, 632 loads of brush, and 71 loads of miscellaneous materials. Private contractors brought in 2,540 loads of leaves, 2,284 loads of brush, 670 miscellaneous loads, and two loads of logs.

68-0099

Zepeda, F. Comparative study of solid waste collection and disposal methods in the U.S.A. and Latin America. Solid waste term problem CE 349. Morgantown, West Virginia University, Dec. 1968. 13 p.

Latin American cities are characterized by a rapid growth of population. Because of this fact, refuse generation grows at a high rate and the traditional collection systems are readily becoming obsolete. The refuse material consists mainly of garbage and rubbish. The problem of abandoned vehicles is not in any way comparable to that in the United States, since old cars are taken apart and sold for their metal value. Their household refuse has a greater density than that of the United States, and it has a greater proportion of garbage than of rubbish. Daily collection is practiced in most cities. By a proper planning of refuse collection vehicles and disposal sites a more efficient collection system could be worked out. The containers used are not made especially for refuse use and vary widely as to weight and volume. Given the local conditions of Latin American cities, curb pickup seems to be the only applicable method of refuse collection. Perhaps the most important difference between collection costs in the United States and underdeveloped countries is the cost of labor. In Latin America, equipment costs determine the cost of collection. Transfer stations have not been used to a great extent in these countries mostly because of the high initial investment. Little has been done in Latin America to provide sanitary disposal of refuse. Open dumps are everywhere, and open burning is a common practice.

COLLECTION AND TRANSPORTATION OF REFUSE

68-0100

American Public Works Association Research Foundation. Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 168 p.

The objectives of the study are to determine the feasibility of a new method of solid waste disposal. A comprehensive evaluation is being made of the costs and benefits obtainable from the collection, transportation, and disposal of solid wastes from urban areas by the use of rail-haul techniques. Phase one is concerned with the identification, development, and setting up of the rail-haul and related solid waste transport and disposal techniques. Phase two will deal mainly with implementation of the rail-haul waste disposal concept in cooperation with selected communities. Phase three will consist of a comprehensive evaluation of the concept and techniques as demonstrated under actual operating conditions during phase two. The findings reported for phase one are still tentative. The conclusions drawn from the information presented suggest the following benefits: a reduction of direct waste disposal costs; a change from inadequate methods of disposal to desirable methods; a better utilization of existing rail installations; a capability for land reclamation; the establishment of an effective disposal system; a potential for widespread application; a high degree of flexibility; and attractive implementation opportunities. It is calculated that solid waste rail haul will cost about \$4.00 to \$4.50 per ton, f.o.b. transfer station. The system--transfer station/rail haul/sanitary landfill--was selected for further evaluation.

68-0101

American Public Works Association Research Foundation. Basic setting for the present solid waste rail haul study. In Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U. S. Department of Health, Education, and Welfare, 1968. p.10-15.

The major rail-haul/disposal system alternatives are identified; the order of magnitude in the economics of solid waste rail shipments is indicated, and the decision making factors in the basic selection of the system to be investigated in this study are outlined. Five major system structures are considered with local collection common to each. The remaining elements of the systems include various combinations of transfer stations, rail haul, incineration, sanitary landfilling, and composting. Rail rates are dependent on specifying each of several dozen variables: the route traveled, type and size of cars used, volume transported, schedule frequency, and type of service required. The economics of rail transport change considerably if large volumes of wastes need to be transported. In terms of the process cost of existing methods, it can be concluded that a combination of rail haul and sanitary landfill offers the best promise for the development of an economical solid waste rail-haul approach. The average cost of sanitary landfilling is reported to range from \$0.05 to \$2.00 per ton. The basic system--transfer station/rail haul/sanitary landfill, was selected for further evaluation.

Collection and Transportation of Refuse

68-0102

American Public Works Association Research Foundation. The methodology for this study. In Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.16-36.

This study concerns both the technical and economical feasibility of solid waste rail haul. Solid waste rail-haul criteria are being developed through an analysis of waste disposal needs as well as the existing disposal operations and their ramifications. The following are also being studied: composition and volume of solid wastes; the transfer of wastes into the rail-haul system; public health and environmental factors; rail transport capabilities; sanitary landfill disposal; and organizational, financial, and legal implementation of rail transport. Correlated efforts for the study include: identification of chemical constituents and properties of solid wastes; evaluation of the potential impact and significance of salvage operations; feasibility and value study of chemical processing for the shipment of waste by rail; investigation of the value of size reduction (shredding); exploratory spot testing of compaction of wastes; comparison with the economics of non-rail modes of transport; evaluation of strip mine operations in relation to solid wastes; and rail-haul studies for selected communities. Research on the compaction of solid wastes will be conducted within the framework of the City of Chicago refuse compression test program. Workshops for State officials and public agencies are part of the project efforts.

68-0103

American Public Works Association Research Foundation. Criteria for evaluating rail haul of solid wastes. In Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.37-40.

A guide was designed to serve the needs and best interests of the public at large and to take into account the concern of groups which could be involved in the operations of a solid waste rail system. The criteria address themselves to the characteristics of an ideal system. It is necessary to consider the criteria combination in terms of an overall optimization. The characteristics of an ideal solid waste disposal system are identified as follows: the system should be capable of handling a great variety of materials and accommodating large and small loads, sudden surges, and seasonal changes; the system should meet public health and environmental control standards and be aesthetically pleasing; the system should operate reliably regardless of climate or weather conditions and other disruptions; the system should be capable of serving large and small communities of various types; the system should be competitive with other systems in respect to total cost and other economic features; the system should have organizational simplicity, offer options, and adapt to user needs; and the system should be publicly acceptable, be open to progress in terms of a product, process, or method evolution, and hold promise for side benefits such as salvage or land reclamation.

68-0104

American Public Works Association Research Foundation. Composition and volumes of solid wastes. In Rail transport

of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.41-55.

A description of the general composition, specific constituents and properties, and volumes of wastes is given. The relevance of composition, volumes, and unit sizes and the influence of salvage on the rail-haul system are discussed. The major sources from which wastes originate can be broadly subdivided as residential, municipal, commercial, industrial, and agricultural. Table containing listings of manufactured and natural products found in solid wastes and their chemical constituents are included. Potential solid waste rail-haul volumes are estimated for annual tonnages as well as the potential daily shipment volumes and their fluctuations. Rail-haul system elements affected by the volumes and composition of wastes include compaction, material handling operations, public health, transport, and landfill. The magnitude of the influence of salvage on the composition and volumes of wastes depends on the type of material removed and its quantity in the waste. Salvage operations might be performed on the landfill site and the concomitant cost reduction would occur. The removal of a large proportion of one type of wastes, such as paper waste, would affect the methods of processing and transport, and the environmental and cost factors of waste disposal.

68-0105

American Public Works Association Research Foundation. Transfer stations for rail haul of solid wastes. In Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.56-98.

Transfer stations are needed in virtually all solid wastes rail-haul systems. Types and sizes of transfer stations, their physical interface with the local collections, waste processing and compaction, and material handling are covered. Seven basic transfer station layout concepts include: a circular design, an 'H' pattern, a compressed 'T' approach, and conventional designs as found in existing stations. The optimum design of a transfer station must take into account the factors associated with the design of collection trucks, collection logistics, and the unloading of wastes; the in-station process and material handling requirements, and the loading of the rail cars. Processing wastes for rail haul improves the cost-to-performance relationship of the overall system operations. Compaction and baling of wastes, besides performing material densification, prevents nuisances such as blowing paper and dust. The decrease in volume depends on the air-to-solid ratio in the waste. Technical considerations, equipment needed, and costs are related to size reduction and compaction of solid wastes. Preliminary results indicated that size reduction leads only to a partial reduction in volume of wastes. A solid waste high-pressure compaction test program has been set up to develop criteria for presses and baling. It is desirable to minimize material handling functions through the layout of the process and to utilize the force of gravity whenever possible.

68-0106

American Public Works Association Research Foundation. The rail transport function in a solid waste disposal system. In Rail transport of solid wastes; a feasibility study; interim

report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.99-135.

The rail link between one or more transfer stations and the disposal site is considered. The rail haul of solid wastes might be implemented by using either existing or specially designed freight cars. Statistics on the railroad network in the United States including the number and cost of the freight cars are given. The applicability of boxcars, flatcars, gondola cars, hopper cars, tank cars, and refrigerator cars to the transport of solid wastes is considered. Data suggest that the cost differential in the shipment of unprocessed wastes and that of highly compacted solid waste decreases with an increase in the total payload of the train. The train configuration is discussed in terms of train-type alternatives and locomotive power. To gain access to desirable disposal sites, it may be necessary to build new tracks in certain cases. An estimate reported by railroad personnel is \$75,000 to \$100,000 per mile or \$15 to \$20 per ft, excluding land. Broadly speaking, rail-haul costing requires consideration of expenses for: maintenance of way and structure equipment; the operation of yards; way and through trains; general overhead and operating expenditures; and the investment. For shipments of about 1,000 tons per day and 100 tons per car, it may cost about \$1.90 per ton to move wastes about 50 miles. Tentative results of a rail network analysis are shown.

68-0107

Sanitary landfill operations with rail haul of solid wastes. In Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.136-155.

Some of the operational requirements encountered in rail-haul sanitary landfills are indicated, the types of sites potentially available are outlined, and some of the results on the disposal of solid wastes in active strip mines are presented. No existing landfill is as large as the one which might be needed in a solid waste rail-haul system. The larger the amounts of wastes disposed of, the lower, it is expected, the unit cost will be. The increase in scale of operations suggests that a completely different type of equipment may have to be used. The alternative types of landfill sites include: sites commonly used in existing landfills, pits and quarries, open pit mines, scrub land, marshes, abandoned and active strip mines, active topography developments, offshore islands and/or in lake and coastal areas, and the ocean. Only one-third of the 3.2 million acres, or 5,000 sq miles of land disturbed by surface mining, has been reclaimed. The opportunity for the disposal of solid wastes in active strip mines depends significantly upon its economic attractiveness to the mining companies. The process flow elements—transfer from the rail car, haulage to the pit, and final disposition of the wastes—determine the cost of the operation. It was tentatively concluded that it is feasible to dispose of solid wastes in active coal mines at a cost of substantially less than \$1 per ton.

68-0108

American Public Works Association Research Foundation. Public health and environmental control in waste rail haul. In Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.156-160.

The environmental factors considered in the study include: the identification of potential sources of pollution, occupational hazards, and nuisance factors; their effect on different system elements; the magnitude of the effects anticipated with respect to the high volumes to be handled by the rail-haul system; the pollution-related implications of processing; and the development of suitable approaches as far as possible and/or feasible to eliminate pollution hazards. A special effort is being made to determine whether and to what degree disease-causing organisms are likely to be introduced into the system from different sources, their possible concentrations, and the likelihood of their survival in the unprocessed and processed wastes. Specific questions which need to be answered in order to elucidate the proper patterns for solid waste rail haul are: the amount and composition of liquid released during compaction; the length of time refuse can be detained in a transfer station; noise and dust control methods that need to be applied; the type of railroad car needed for wastes; the time that a loaded car can stay at the station; the procedure if a car loaded with refuse goes astray; and the implications of the high-volume solid waste rail-haul landfills.

68-0109

American Public Works Association Research Foundation. The organizational, financial, and legal implementation of transporting solid wastes by rail. In Rail transport of solid wastes; a feasibility study; interim report: phase one. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.161-167.

The final decision on the application of waste rail haul will have to be made, in most cases, by local community leaders. Community workshops, with public agencies participating, are important in determining rail haul feasibility, how the rail haul should be executed in terms of local conditions, and what specific benefits can be identified and dimensioned in terms of both performance and cost. It is necessary for States or State agencies to become involved, because solid waste rail haul, by its very nature, will operate on a regional, super-regional, intrastate, or even interstate basis. The State workshop is to pursue three basic objectives: to discuss the functions States might execute to set up and to operate a rail-haul system; to identify areas where existing State laws and regulations might impede optimum performance; and to enlist the cooperation of appropriate State agencies. The departments mainly involved are Sanitation, Public Utilities, Conservation, State Planning, and Industrial Development, and the Governor's office. Specifically, the State workshop might deal with the identification of State and Federally owned land, the location of disposal sites, the operation of a sanitary landfill network, public relations, and a rail-haul demonstration project. Examples of the alternatives for the legal entities which might be responsible for a rail-haul system are given.

68-0110

Association plays major role in equipment development. Solid Wastes Management/Refuse Removal Journal, 11(5):24, 89, May 1968.

The Chicago and Suburban Refuse Disposal Association has played an important role in the development and use of

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sanitary equipment in this city. In the early 1950s, when Chicago passed an ordinance requiring use of totally enclosed vehicles, this association proved to city officials that the statute would seriously hinder collection of certain types of wastes until suitable designs were developed. The early closed vehicles, namely the Gar Woods, the Heils, and the Leaches, were unsuitable for hauling ashes, since the packer plates did not develop sufficient upward thrust to move the material properly. A unit developed by one of the contractors in 1957-1958 incorporated a hydraulic tailgate with steel covers on the body top which proved practical in the removal of ashes. In 1958 the Association informed city officials that it could now conform to the previously passed ordinance.

68-0111

Babcock, H. A. Slurry pipelines—the dark horse in the materials handling race. In *Proceedings; Mineral Waste Utilization Symposium*, Chicago, Mar. 1968. U.S. Bureau of Mines, and Illinois Institute of Technology Research Institute, p.148-152.

Advantages such as adaptability to automation, relative stability of operating costs, indifference to bad weather, low construction and right-of-way costs, and easy maintenance are inherent in pipeline transportation of solids. An approach to economical design of pipelines is discussed. Preliminary estimates and the designer's formula are given, and the equation is used to plot curves of head loss vs. velocity at constant concentration. With these curves, daily operation of the line can be planned in accordance with production schedules and storage facilities.

68-0112

Berry, L. H. Trash rake cuts downtime. *Power Engineering*, 72(11):75, Nov. 1968.

The Berry Trash Rake was designed to clean trash racks in steam plants, pumping stations, and similar installations making plant shutdowns to clear brush, logs, bark, leaves, and other trash from the bottom of the racks unnecessary. The rake has positive control and full maneuverability over the entire rack and its immediate environs. Since all its motions are powered, it can force its way through ice or other debris and is not handicapped by deep water. The boom of the rake is carried on a four-wheel gantry which rides on a track. Debris collected from the rack is brought to the platform on the gantry for later disposal.

68-0113

Bevan, R. E. Refuse collection and disposal. *Surveyor and Municipal Engineer*, 131(3975):87-90, Apr. 1968.

Pipeline carriage of house refuse to the disposal works could develop as a "dry" method using the vacuum principle now being investigated at Westminster. Meanwhile, refuse disposal and collection is an essential service and men are needed to provide the service. For this reason, the job of refuse collection must be made more desirable. The refuse which is now with us is approximately 40 to 50 percent paper and 30 to 40 percent garbage by weight. This composition must be carefully examined and its impact on refuse disposal practices considered. Also, it makes an examination of the practice of burning unseparated refuse necessary. The most essential

component of optimum refuse disposal is thought to be national and regional coordination. New and more stringent punishment for irresponsible dumping is recommended to strengthen collection and disposal activities, especially in regard to abandoned cars.

68-0114

Brown, G. E. Development of refuse collection vehicles and thoughts on the future. *Public Cleansing*, 58(10):533-544, Oct. 1968.

A hydraulically operated ejection plate giving horizontal discharge is looked on as a means for discharging refuse vehicles which are compacted so that they will not readily discharge by gravity. This would simplify work at many disposal plants and tips. Strain on the vehicle would be reduced by using a rigid non tipping body. As an alternative to long distance hauling of refuse in refuse vehicles or to transfer stations, containerized handling of refuse is suggested whereby a full, compacted load could be ejected into a large hauling vehicle and remain intact. Noise abatement was considered important, and use of electric powered vehicles, when and if they become economically feasible, is considered.

68-0115

Bugher, R. D., and K. Wolf. Rail-haul refuse disposal...using high-pressure compaction of wastes shows promising economies. *American City*, 83(8):79-80, Aug. 1968.

The APWA Research Foundation is engaged in a research effort to explore the potential use of rail haul. The U.S. Public Health Service's Solid Wastes Program is financing two-thirds of the project. Rail haul could be incorporated into all systems in which sufficient quantities of waste have to be transported over long or even relatively short distances. Rail haul can transport the raw waste or incinerator residue. Three major elements of a rail-haul system are: transfer stations, the rail-haul link, and the ultimate disposal operation. Preliminary findings indicate that the compression and/or baling of refuse is the most effective and economical way for handling wastes in a rail-haul system. Four different train-types are under consideration: attachment to a regularly scheduled freight train; a special train totally dedicated to the hauling of wastes; the empty haul of an existing unit train; and the Rent-A-Train concept. Rail haul can be utilized in conjunction with sanitary landfills and can complete land reclamation projects quickly. Disposal of refuse by rail haul might be accomplished at about \$4 per ton.

68-0116

Coal pipeline revived to carry wastes. *Electrical World*, 170(15):22, Oct. 28, 1968.

In a test sponsored by the Department of the Interior's Federal Water Pollution Administration, the 108-mile pipeline which served for a 4-year period to transport coal from Cadiz to Cleveland, Ohio will transport wastes in the reverse direction. In addition to helping Cleveland solve its waste problem, the delivery of solid wastes is expected to aid in the reclamation of the barren land resulting from strip mining in Harrison County. A mixture of 95 percent water and 5 percent solids, including sludge from the Southerly

Sewage Treatment Plant, dredge material from Cleveland Harbor, and fly ash from power plants, will be used in the line. Before being sent through the 10-in. pipeline, the sludge will be treated in the sewage plant to destroy odors.

68-0117

Conversion to municipal refuse collection results in multiple benefits. *Public Works*, 99(2):78-79, Feb. 1968.

Saline, Michigan (population 4,200), was faced with the problem of setting up a municipal rubbish collection system in less than 2 months when the existing refuse contractor did not renew his contract. A Diamond Reo split cab truck unit with a 25-yd Gar Wood packer body was selected to fill the need for a high-capacity packer and maneuverable refuse truck. The city now provides complete garbage and refuse pickup once a week. In adding the cost of operation, maintenance, salaries, depreciation, and other expenses, an annual net cost of \$21,000 is projected—a saving of more than \$11,000 over the previous system. The quality of the service has improved and the scope of operation has expanded to include all rubbish collection.

68-0118

Crellin, A. D. An investigation into the vacuum system of refuse collection. *Public Cleansing*, 58(8):409-417, Aug. 1968.

The vacuum cleaner principle is employed to remove refuse from a building to a transfer station or a separation plant. At present, in Sweden, this system is used in a large hospital and in a development of multi story dwellings near Stockholm. The development, when completed, will cover 225 acres and will consist of 3,000 flats divided into 30 blocks and served by 144 refuse chutes. Since the plant began operation, there have been no blockages or breakdowns reported and no sign of wear in the transporter tube. The advantages of the system include: expansion of the system to cover refuse increases by increasing the number of transport operations per day; freedom from collection vehicles, noise etc.; freedom to collect refuse on any day without difficulty; automation, which eliminates the need for refuse collectors and the increasingly high wages which they command. The vacuum in the exhaustor is at three in. and the velocity of air in the pipe is 55.2 mph, 81 ft per second. Twenty or 24-in. pipes are utilized. The chute doors are designed to prevent the introduction of large, unwieldy objects, and there have been no problems with children or animals in the system. The method of repair is to dig up the pipes at the point where replacement or repair is needed.

68-0119

Denver eyes rail transfer stations. *Solid Wastes Management/Refuse Removal Journal*, 11(1):8-9, 14, 18, Jan. 1968.

The Denver and Rio Grande Railroad has submitted a proposal to the City of Denver, Colorado, to dispose of household wastes collected by municipal trucks which would haul the refuse to a pair of in-city, truck-rail transfer stations to be built by the railroad. The latter would haul the refuse to a site owned by Landfill, Inc., which is reputed to own

enough land to assure disposal for the next 40 years. The transfer stations would provide unloading ramps at which eight trucks will simultaneously be able to discharge their loads into a surge bin. The trash would be moved via a rotary plow-conveyor belt system to shredders which would have the capacity to accept trash with densities to 370 lb per cu yd, and grind and compact it at the rate of 350 cu yd per hr, to a density of about 650 lb per cu yd. The railroad proposes to charge the city \$4.50 per ton for a guaranteed minimum of 875 tons of refuse per day. The cost would be offset by money saved after stopping current trash burial and incineration, and by the reduced mileage per trash truck. The trucks now travel to a site about 12 miles from Denver, and will have to travel further when present disposal sites are closed.

68-0120

Efficient refuse collection. *Public Works*, 99(4):136, Apr. 1968.

About 35 tons of residential refuse and 25 tons of commercial refuse are collected daily in Merced, California, which has a population of 24,000 and is the center of a trading area of about 50,000. There are no private haulers or contractors operating inside the city limits. To facilitate collection from back yards, a 70-gal can carrier on roller-bearing wheels was developed. All commercial routes are operated by one-man crews; residential routes by two-man crews. A front-end loading truck has been purchased and a complete city-owned container system has been initiated. The entire downtown business district will soon be containerized. The first diesel-powered packer has been in satisfactory service for more than 2 years, and more will be purchased.

68-0121

Evans, H. Transfer stations solve dump problems. *Public Works*, 99(5):84-85, May 1968.

King County, Washington, which includes a dozen smaller cities in addition to Seattle, utilizes transfer stations to solve garbage disposal problems. The transfer station is built on two levels, the upper for access by vehicles to be dumped and the lower for trailer trucks to receive the refuse. Low-bed trailers with tractors transport about 80 cu yd of refuse to a central disposal site. Commercial backhoes were redesigned to serve as compactors. A hydraulic scooper, fitted with specially designed arms which pick up the big steel containers and flip them over for emptying, was adapted. Approximately 900 tons per day are handled in all seven transfer stations. A sketch shows the two-level structure and the layout of the unloading floor.

68-0122

The flow of solid wastes in pipelines. *Compost Science*, 8(2):11, Autumn 1967-Winter 1968.

Among the research projects now being supported under the Solid Waste Program of the Public Health Service is a study by Dr. Iraj Zandi of the University of Pennsylvania who is exploring the pipeline collection and transportation of solid wastes. Despite the potential of solid pipeline systems, the

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inability to accurately predict the headlosses that will occur has been one of the factors impeding the development and widespread use of hydraulic transportation. Experiments have shown that ground-up municipal refuse could be mixed with a small amount of water from the city sewer system and pumped out of the city. Pipelines would only have to be of 2-in. diameter to carry the wastes of a town with a population of 10,000 to 15,000. In the future, magnetic and centrifugal sorting devices may be used to remove metals, glass, and plastics for salvage. Industrial installations of pipeline transportation in the United States and Europe are listed.

68-0123

Fowler, J. A. The growing problem of garbage - and how an engineer hopes to improve collection. One method under study: by pipeline. *Pennsylvania Gazette*, p.16-20, Mar. 1968.

Metropolitan areas face urgent crises of solid wastes disposal. In 1965, Congress, recognizing this fact, passed the Federal Solid Waste Disposal Act authorizing over \$750,000 for grants to study new collection methods. One such study considers if pipeline collection and transport is workable and more economical than truck collection. Trucking possesses the disadvantages of being inefficient, unsanitary, unsightly, and inconvenient, besides demanding land and unskilled labor. With the pipeline-slurry method, homes and businesses equipped with solid waste crusher machines would pulverize garbage. Small, high-pressured pipelines would then transport the grindings through existing sanitary sewer lines to central collection points for treatment, reclamation, composting, or dumping. No delayed pickup, odor, vector, or fire problems would result. The plan is an application of fluid mechanics: waste water mixed with crushed waste travels speedily, entrapping the solid waste particles, and carrying them alongside. Experiments considered variables of size and composition of the wastes, employing different pulverizers, pipe size, speed of flow, and slurry properties. Although more exploration is necessary to develop a cheap, efficient system outside the lab, the findings proved that with present technology solid waste can be crushed and pumped more economically than present methods used by large towns. Feasibility for small towns must be investigated. Social and political implications, such as the effects on slums and unskilled labor and financing the initial costs require additional thought.

68-0124

Fowler, J. A. Truck collection no longer is 'acceptable' for city refuse. *Compost Science*, 9(2):12-15, Summer 1968.

As a result of a study at the University of Pennsylvania, the pipeline method is proposed to replace the present truck method of collecting garbage. Homes and businesses would be equipped with some type of solid waste crusher machine, similar to sink disposal units but larger in size. Owners would empty garbage into chutes leading down to the pulverizers. After the garbage was reduced, it would empty into pipelines and be carried away. The system would be onsite, and the problem of delayed collection is eliminated. The idea behind the plan is an application of a law of fluid mechanics: if a liquid (slurry) or gas (pressurized air) traveling at a high rate

of speed is able to entrap solid material and carry it along, waste water mixed with crushed solid waste traveling at a high rate of speed should entrap the solid waste particles and carry them along. Based on the data obtained, it is estimated that the residents of Philadelphia will spend some \$90.6 million over the next 50 years to collect and remove solid waste to a distance of 50 mi. The study showed that it would only take \$88.3 million to put a completely automatic piping system into operation.

68-0125

Freaney, J. A. Appendix G. Collection vehicles and disposal equipment. In *Summer study on the management of solid wastes; final report*, v.1. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968, p.43-45.

Three areas of interest were covered and evaluated: an incinerator which handles small volumes, a size-reduction machine producing briquettes, and a German refuse vehicle body. The incinerator and size-reduction machine are not complete disposal answers, but could, if proven effective, be useful for many industrial and commercial concerns. The German refuse-vehicle body was by far the most promising of all equipment observed. It could go far in reducing collection costs, and it is described. A short list of recommendations for future action is also furnished.

68-0126

Garbage ticketed for next fast freight. *Engineering News-Record*, 181(22):36, Nov. 28, 1968.

San Francisco's city administrators have been authorized to draw up a contract with Western Pacific Railroad to haul the city's garbage into the Lassen County desert in northern California. It is estimated that it will cost about \$3 million per year to haul 1,300 tons of garbage 375 miles daily to the disposal site. The city will pay about \$6.50 per ton for shipment and Lassen County will get about \$25 per ton for taking the garbage which will be buried in trenches. In San Francisco, Western Pacific plans to build a midcity garbage transfer terminal where scavenger trucks would dump their loads into containers. The containers would be shipped by barge to Western Pacific's East Bay tracks for departure for the desert. Citizen groups near the terminal and in Lassen County are voicing protests.

68-0127

Goodman, L. R. Strict truck regulations essential to fleet operation. *Solid Wastes Management/Refuse Removal Journal*, 11(10):30, 75, Oct. 1968.

Control instruments placed on vehicles have prevented drivers from introducing practices that are deleterious to the equipment. A device on the truck will cut off the engine when a certain temperature is reached. A mechanical stop on the accelerator prevents racing the engine to obtain faster power takeoff action. Wooden shoes in refuse bodies have been replaced by steel shoes with a modified track. These and other measures have reduced maintenance costs and downtime. However, since preventive maintenance is difficult in the refuse industry, equipment is replaced every 2 years.

68-0128

Hopper streamlines dirt collection. *Water and Sewage Works*, 115(8):361, Aug. 1968.

To streamline the collection of dirt and sludge from manholes which provide access to electric power lines, Detroit Edison Company has turned to the use of a truck-mounted, self-dumping hopper. A man shovels refuse into a bucket lowered by a hoist, and when the bucket is full its contents are emptied into the 2,000-lb capacity hopper. Under the old manual system, it took one morning to clean a single hole, while the new equipment makes it possible to clean as many as a dozen per day.

68-0129

How to dispose of a cooker. *Engineer*, 225(5849):353, Mar. 1968.

The Greater London Council believes it has solved the problem of the disposal of unwanted bulky articles by setting up 38 depots throughout London for receiving such items and later collecting them free of charge. There still remains the problem of transportation and labor to get the item to the depot.

68-0130

Lausch, J. How to transfer refuse—elegantly. *American City*, 83(10):85-87, Oct. 1968.

A new refuse-transfer station serves the 150,000 residents and numerous industries of Lancaster, Pennsylvania, and the six townships surrounding it. For the 17-mile trip to the landfill, 65-cu-yd transport trailers are used. The clients are charged by the weights of their loads. These fees finance completely the costs of both the transfer station and the sanitary landfill. The loading system employs push-out heads and pits 10 ft wide to insure adequate refuse storage capacity, and an automatic sprinkling system is used to settle dust and even deodorize when necessary. The structure is equipped with four dumping stalls on either side of a small control room. If one of the two center stalls is chosen, refuse drops directly into a refuse transfer packer on the floor below, which periodically pushes this material into one of the transport trailers. When filled, it leaves and another takes its place. Five such trailers are used to shuttle between the station and the landfill. Initial costs of the system, operation, and specifications of the trailers and related equipment given.

68-0131

Mendoza, E. Larger trucks permit reduction in collection crew size. *Public Works*, 99(4):106-109, Apr. 1968.

In 1966, the City of San Diego converted from a three-man to a two-man refuse collection crew. The refuse service comprises once-a-week, combined rubbish and garbage collection in residential areas and multi-weekly collections in commercial areas. The collection system is arranged around three stations which operate as headquarters. A landfill is located near each site. The change in crew size was permitted by use of a 25-cu-yd packer truck instead of the 20-cu-yd truck which had been used before and through establishment

of a higher paid classification to which workers may be promoted. The two-man crew now collects the same average workload, 14.25 tons, as the three-man crew did formerly due to reduced travel times. Direct cost savings have been realized—the old system cost \$7.83 per ton vs. \$6.24 per ton for the new system. Safer operation, promotional opportunities, reduction of total number of personnel, and improved public relations are cited as additional benefits.

68-0132

New collection trucks solve sanitation problem. *Public Works*, 99(8):109, Aug. 1968.

Garfield Heights, Ohio, has been able to switch from biweekly to weekly refuse pickups due to the purchase of two 40-cu-yd capacity Gar Wood (T-100) refuse collection trucks. Data are provided showing savings in diesel fuel, oil, and repairs between the T-100 and conventional 20-cu-yd packer. Instead of handling the city's refuse operations by six units on a 6-day basis, the department uses only five units, with one being held in reserve, in a 5-day week. With the new trucks it has been possible to eliminate special pickups after residents clear their attics or garages of rubbish and debris and the larger 40-cu-yd capacity enables refuse to be collected all day without a midday trip to the local landfill.

68-0133

Perl, K. Economic management of domestic waste collection by motor vehicles. *Ingegneria Sanitaria*, 16(5):362-364, Sept.-Oct. 1968.

A mathematical formula developed by F. C. Wuethrich is used to make certain deductions about the transportation cost of solid waste by motor vehicles. Several curves are established and minimum collection costs are determined with load capacities from 3 to 20 tons per car and transportation of material up to 50 km. The number of employees connected with the collection varies from three to seven, depending upon the distance; the greater the distance, the lower the supporting crew (three men for 46-50 km), and the shorter the transportation line, the more numerous the workers (seven men for 0.0-0.8 km). It is also noted that cost decreases with increase in load capacity of the vehicle. However, the savings of transportation costs between a vehicle carrying 20 tons and one of 10 tons for a distance of 2 km is only 1.5 percent. This economy increases to 9 percent when the distance goes up to 50 km. Calculated optimal capacity is 15 tons and minimal capacity approximately 6 tons. These formulae can only serve as a guideline and may not correspond to actual conditions. (Text-Italian)

68-0134

Quon, J. E., M. Tanaka, and A. Charnes. Refuse quantities and frequency of service. *Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers*, 94(SA2):403-420, Apr. 1968.

Significant changes in the quantities of refuse from wards 17 and 25, City of Chicago, as a result of the initiation, in 1966, of twice-a-week pickup service in approximately one-third of the living units serviced was determined. A method for

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making comparisons based on information from similar neighborhoods and identical time periods was developed and used in the analysis. For ward 17, the twice-a-week pickup service resulted in 83 lb per week per living unit, while the once-a-week pickup service resulted in only 51 lb per week per living unit. Similar analysis for ward 25 resulted in 71 lb per week per living unit for twice-a-week service and 66 lb per week per living unit for once-a-week pickup service. The percentage increase in refuse quantity with greater frequency of collection was independent of the season and essentially constant.

68-0135

Ralph Stone and Company, Inc. Field survey and analysis. In A study of improved refuse collection systems comparing one-man with multi-man crews. Cincinnati, U.S. Department of Health, Education, and Welfare, June 1968, p.3-44.

A program was initiated in July 1967 to undertake comprehensive field surveys of refuse collection operations of four cities and two private collection firms located in California. These surveys were intended to determine: collection time for various crew sizes and collection methods; travel time between collection stops; the number of refuse/service stops; and the number and type of containers at each service stop. Abbreviated field surveys were made at other locations throughout the country. The field survey data are summarized in tabular and graphic form. One-man crews were more efficient than multiman crews for curbside and alley collection. Multiman crews were more efficient for backyard carryout collection of refuse. Significant savings in curbside collection time were achieved by the use of disposable containers such as paper or plastic bags. Extensive studies of a TRAC (Truck Rear Actuated Control) unit indicated average man-hour savings of about 25 percent.

68-0136

Ralph Stone and Company, Inc. National survey of collection practice. In A study of improved refuse collection systems comparing one-man with multi-man crews. Cincinnati, U.S. Department of Health, Education, and Welfare, June 1968, p.44-63.

A total of 234 cities in 42 different States, with a total population of 37,397,837, cooperated in the study by supplying system data. The ratio of cities providing public collection service as opposed to private collection was approximately 2½ to 1. Rear-loading equipment received the greatest use. The majority of sanitation collection equipment was serviced by a three-man crew. The most common location designated for municipal refuse collection was a combination of curb and alley. There was a preference for either once or twice a week collection in the sampled cities. Last time accident experience reported by 80 cities averaged 1,457 accidents per year. A sample of 166 cities reported average collection costs of \$17.66 per ton per year.

68-0137

Ralph Stone and Company, Inc. Time and motion analysis. In A study of improved refuse collection systems comparing one-man with multi-man crews. Cincinnati, U.S. Department of Health, Education, and Welfare, June 1968, p.63-95.

Based on motion picture and video tape recordings, a list was made of basic human motions required to perform the refuse collection task in one-, two-, and three-man systems and MTM (Methods-Time-Measurement) values were applied. The basic motion data was formulated into the elements: dismount from truck, walk to container location, grasp and pick up container, pivot and walk with container to loading location, dump container contents, pivot and return with container to storage location, place container on ground and pivot, return to cab, and mount truck. Figures illustrate the results and methodology of the time and motion analysis for curbside, backyard, and alley collection, and modified curbside collection by one-, two-, and three-man crews. Special analysis was applied to problems of fatigue and delays due to such things as parked cars, spillage, and scavenging.

68-0138

Ralph Stone and Company, Inc. Mathematical model. In A study of improved refuse collection systems comparing one-man with multi-man crews. Cincinnati, U.S. Department of Health, Education, and Welfare, June 1968, p.95-145.

A limited mathematical model was developed describing the time required for the collection of refuse. The factors included in the model were: mean quantity of refuse per collection stop; driving time between the route and the disposal site; mean collection time at each collection stop and travel time to the next stop; total nonproductive time; and mean disposal time per load at the disposal site. Most of the simulation work was conducted to compare one-, two-, and three-man collection crews for curbside collection with a few simulations completed for backyard, alley, and modified curbside collection systems. The volumetric capacity of the refuse collection vehicle and unit cost per ton were compared for various crew sizes and services. A series of nomographs has been devised to give the refuse collection operation manager tools for the study of the internal workings of his operation.

68-0139

Ralph Stone and Company, Inc. Equipment. In A study of improved refuse collection systems comparing one-man with multi-man crews. Cincinnati, U.S. Department of Health, Education, and Welfare, June 1968, p.145-149.

Background information, specifications, and brochures on refuse collection equipment suitable for use by a one-man crew were compiled. A summary of pertinent specifications from manufacturers of American equipment was included. Photographs illustrate typical European equipment. Of existing American-made refuse collection equipment, the side-loading, packer type vehicle is probably best suited for one-man operations regardless of methodology. This equipment enables the operator to complete the collection tasks with a minimum of lost-time effort. With curbside collections, the side-loading packer equipped with right-hand drive may prove more efficient. Rear-loading packers are satisfactory for one-man operation, although somewhat less efficient than side-loaders in terms of crew time.

68-0140

Rapid collection system. Materials Reclamation Weekly, 113(1):30, July 6, 1968.

A system, which lifts containers up the sides of vehicles and dumps the contents which are then compacted, is now being manufactured in Great Britain. It is already in considerable use in many countries under extreme climatic conditions. It is operated by a low speed, high torque, piston hydraulic motor. Three standard sizes are available having lifting capacities of 8, 12, and 16 tons. A wide choice of standard body types is available. The system can be readily installed on standard commercial vehicles. One of the two designs available, the VL Nalli 2, incorporates an inner compacting wall operating on rails and powered by a hydraulic motor. Waste bins are automatically lifted up the side rails and dumped, returning the emptied container to the operator who then controls the compacting wall by hand levers. The VL Nalli J2 is a similar container, but loading is done manually through two side doors. Both containers weigh about 2 1/2 tons and can carry up to 6 1/2 tons. Volume is approximately 20 cu yd. A patented device insures that the two steel cables exert an even pull.

68-0141

Refuse chutes standard. Public Cleansing, 58(5):252, May 1968.

British Standard 1703 was first prepared at the request of the Building Divisional Council in order to indicate a general design and suitable materials for refuse chutes for multistory buildings. The first edition included certain matters concerning the use of domestic refuse systems which at that time were not covered by a British Standard Code of Practice, CP 306. The various methods of jointing the chute components, methods of connection with the hoppers, and general guidance on installation are covered in this code. The standard specifies requirements for refuse chutes in the form of one or more vertical pipes receiving refuse from successive floors in a building and discharging it into refuse storage containers, housed with a chamber situated at the lower end where bulk removal takes place at intervals.

68-0142

Refuse disposal via railroad. Public Works, 99(7):92, July 1968.

A 4 year contract was authorized by the Philadelphia City Council for the disposal of refuse by landfill in strip mines of upstate Pennsylvania. Under the terms of the contract, at least 260,000 tons per year of refuse will be moved on the Reading Railroad to the strip mine sites. The cost of disposal will be \$5.39 per ton as compared with present costs of \$7.50 per ton. Two transfer stations will be built in Philadelphia near existing incinerators and along the Reading tracks, where the refuse will be processed (shredded and baled) for loading on cars. The city will operate a fleet of trucks necessary for the collection of household and municipal refuse, and will collect it and transport it to the transfer stations for disposal. The refuse will include rubbish, garbage, ashes, street and inlet cleanings, and public refuse not normally collected by the city. Pathological products, hospital or nursing home refuse, or any material specifically excluded by the State Health Department will not be included. The basic design for the transfer stations includes two shredding machines, a compressor and baler, two overhead cranes, and two railroad tracks each capable of

handling six cars. The landfills will be in the strip mine areas in upstate counties, including Carbon, Luzerne, Schuylkill, and Northumberland. The maximum depth of each layer of trash is to be 4 ft. Each layer will be covered with a maximum of 2 ft of fill compacted by bulldozers. This will eliminate air pockets. Trash fill will stop 20 ft below the surface of the stripping. The final 20 ft will be filled and compacted using the loose earth, clay, and shale in and around the stripping, and capped with a runoff dome. The surface will be planted with a fast-growing particularly adapted evergreen of a species recommended by State and other experts. State inspectors will continually monitor the operation.

68-0143

Refuse in the pipeline. Surveyor and Municipal Engineer, 132(3982):1-2, Sept. 27, 1968.

In a brief section of his presidential address given to the Institution of Public Health Engineers, Gwilym Roberts said that curbside collection of domestic refuse was not consistent with modern public health standards. One solution for suburbia lies in the under sink waste disposal unit. Pipeline disposal in some form seems to hold out the only practicable answer. In this case, the sewerage systems must be made large enough to handle extra bulk, and the function of disposal works must be expanded to deal with more and different solids. Various authorities are using refuse as a fuel, and the next step could be to pipe the fuel to the boilers.

68-0144

Rolfe, D. G. Raising productivity in the refuse collection service. Public Cleansing, 58(6):293-306, June 1968.

This paper, which was presented at a London meeting April 19, 1968, discusses ways of increasing productivity in refuse collection service: incentive bonus schemes; container systems; and other methods of collection. The commonly used incentive bonus schemes, advocated by Report No. 29 of the National Board for Prices and Incomes in 1967, do not seem to increase or maintain productivity. He suggests that a locally agreed rate that would make unnecessary a bribe to complete work that was already paid for. New methods or equipment reducing labor requirements should be introduced. An investigation by the Work Study Officers to assess the true labor costs of all systems of refuse collection is suggested. The system of refuse collection should provide sufficient space for later requirements and should be flexible enough for changes. A collection service which is cleaner and quieter to operate, requiring a driver and only one man rather than the present British Standard (B.S.) container teams is suggested. A refuse compression and packaging device, that can be chute or hopper fed, and that is no larger than a B.S. container, or the use of plastic liners for the containers is recommended. The adoption of a large container system with capacities up to 12 cu yd is also recommended, although this may eventually be replaced by three developments: the Deva system whereby refuse is hydraulically pressed into paper bags ready for collection; containers with built-in compression devices; and direct loading. A discussion of the paper and the author's reply is included.

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68-0145

Saigon garbage situation serious too. *Clean Air News*, 2(5):19-20, Feb. 20, 1968.

With nearly 2 weeks of uncollected garbage in the streets, the Saigon Sanitation Department moved one step closer to a full resumption of service as 183 garbage collectors and 194 street sweepers reported back for work. The security problem, the citywide curfew, the displacement of thousands of city dwellers, and a curious apathy added to the sanitation problem. The government began ordering families to burn their garbage in the street, leaving the city with a smoky, acrid smell. The sanitation department has a budget of about \$1.5 million for a city of about 2 million.

68-0146

Schultz, G. P. Managerial decision making in local government; facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968. 263 p.

The purpose of this study is to discover a rationale for facility planning for a solid waste collection system and devise an operational decision model consistent with the rationale. The role of such work in the decision-making role of a system manager in local government is emphasized throughout. A serious attempt has been made to describe the important decisions to be made and to adapt methods to these problems. The decision model which is developed consists of several submodels, each of which provides a proximal solution for a subset of the decision variables. The submodels are the typical facility and service area, the facility location pattern, and the facility timing strategy. The derivation of each of these models, the assumptions, and the functions used are detailed with graphs and illustrations. Data developed through use of an hypothetical city are given. The facility location and facility timing simulation programs and a list of references are appended.

68-0147

Schultz, G. P. Introduction. In *Managerial decision making in local government; facility planning for solid waste collection*. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968. p.1-9.

An attempt to develop methods to be used by the manager of a public solid waste collection system to plan a set of facilities for a city is presented. Careful study of the contexts in which a system manager works, the general form of the system, and the rationale for decision making as well as the design of specific systems, and the choice of the best one, is considered. The collection of solid waste from households is the subject and the collection vehicle transfer station-haul vehicle system is the system used. The decision problem had been reduced to choosing a facility plan consisting of an optimal pattern of facilities for each of several points in time. The mission of the solid waste collection system is to provide a specified frequency and quality of service over some planning period for all community members at minimum cost. The measure of output of the system is the volume of domestic solid waste picked up, processed, and transported to a disposal site. To gain insight into the critical issues of solid waste collection problems, literature was reviewed and

interviews conducted. However, data was not available, so the forms of the descriptive models used are based on a rational explanation of the system rather than direct empirical evidence. In order to avoid the need for very complex models, a set of simple functions involving critical parameters was selected. The decision model is divided into three submodels: a hypothetical city is introduced, and an optimal facility plan is generated using the submodels.

68-0148

Schultz, G. P. Managerial decision making in local government. In *Managerial decision making in local government; facility planning for solid waste collection*. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968. p.10-29.

Decisions concerning the kinds of solid waste collection facilities to be provided, and the allocation of funds and the distribution of costs and benefits resulting need to be made. A system in which the effects of budgeting and planning decisions are estimated by public managers and the ultimate decisions are made by elected representatives is assumed. The two major kinds of criteria used to justify public expenditures are economic efficiency and economic welfare. Economic efficiency is handled by evaluating efficiency criteria; economic welfare criteria are met through the political scheme. In a centralized decision making system, a hierarchy of decision levels exist: budgeting, urban planning, system planning, system programming, and design and system operation. Analysis, based on empirical evidence of needs and resources and rational comparison of alternative programs, is believed to be necessary to maximize the effectiveness of the overall program of public services. The system manager must make planning programming and operating decisions. However, the difficulties are reduced because a great many factors are given by market and political forces. A rather sophisticated methodology has been developed for system analysis which draws on existing disciplines such as economics, mathematics, and statistics. In addition, new fields such as operations research, systems analysis, and management science are being adapted to public systems.

68-0149

Schultz, G. P. Solid waste collection service. In *Managerial decision making in local government; facility planning for solid waste collection*. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968. p.30-57.

In 1965, an estimated 150,000,000 tons of solid wastes were collected and disposed of by private and public services. The cost of collection and disposal was about \$3 billion. Annual collection and disposal for the City and County of Los Angeles in 1960 were estimated to be \$5.65 per capita of which about 80 percent was spent on collection facilities and operations. The source system of the solid waste system is the set of residence units within the jurisdiction of the solid waste agency. A collection system consists of collection vehicles and, in some cases, transfer stations and long-haul vehicles. The benefits to households of collection systems include health and convenience. Because of this growing importance, serious attempts to understand the issues involved, to develop a better technology, and to increase the effectiveness of current technology are cited in various

publications and studies. The main reasons for introducing a systematic approach to facility planning are to make the logic of decision making more explicit and to allow more relevant data from the specific situation to affect the decisions. The planning of facilities is considered along with the design of other elements of the system. A decision model is a coherent framework for describing the system and for decision-making, using such concepts as the production function, cost function, and decision rule to form a decision model.

68-0150

Schultz, G. P. The decision model. *In* Managerial decision making in local government facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968, p.58-72.

Although the decision-making problems involved in planning a solid waste collection system are difficult, the general form is described. The system elements are collection vehicles and their crews, transfer stations, associated equipment and personnel, and long-haul vehicles and their drivers. A typical transfer station is illustrated, and photographs of operations are included. The processing activities which take place at a transfer station are considered. Processing parameters derived from operating, maintenance, repair, and cleaning procedures are the same for all facilities. The routes to be covered by collection vehicles are programmed by a central scheduling office to reduce travel time, to assure that the vehicles are filled, and to distribute arrival times at the transfer facility to avoid queuing. The pickup frequency is an important system parameter. It is assumed that the most efficient form for the service area of a single transfer station is a contiguous area surrounding the facility.

68-0151

Schultz, G. P. Basic cost functions and parameter estimates. *In* Managerial decision making in local government; facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968, p.73-90.

The decision problems involved in facility planning require carefully stated models describing physical and cost relationships among variables. The critical variables should be quantifiable, and their relationships clear enough that mathematical models can be used to describe them. The variables involved in a system may be categorized into environmental, system, and mixed, parameters. Each of these variables is explained in detail. The overall decision model developed here begins by establishing a facility capacity-location and a service area size-form which are typical for the city as a whole for some point in time. Next, typical facilities and service areas are distributed over the city and modified to form an efficient set. Then in response to demand, facilities are expanded in a manner which minimizes cost over a long planning period. The steps which make up this model are grouped into three independent submodels: the typical facility and service area submodel; the facility location submodel; and the facility timing submodel. The purpose of each submodel is to minimize direct cost per household. A sensitivity analysis is used to determine the extent to which costs change if the values of parameters or decision variables differ from expected values. The decision

model is a device for organizing available information; the network of assumptions have to be adjusted to each specific problem.

68-0152

Schultz, G. P. Basic cost functions and parameter estimates. *In* Managerial decision making in local government; facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968, p.91-117.

The derivation of basic cost functions for facility construction, processing activities, and collection activities to be used in the submodels are noted. The facility cost is determined by non-quantifiable attributes of the facility (facility quality) which are assumed constant for all facilities at all points in time, and by initial facility costs which may be determined through use of functions given. The function for determining annual facility cost is also given. The functions necessary for determining processing costs are detailed with definitions and assumptions implicit in its derivation. Collection activities include travel from the transfer station. Costs associated with these activities are rental equivalents for collection vehicles and wages for vehicle crews. Further simplifying assumptions used are: each household receives the same number of pickups per week; travel time is proportional to distance and collection vehicle capacity is constant; crew size is constant; and each crew works an 8 hr day. The variables to be used are defined, and functions for determining collection costs are given. The parameters of the cost functions would ordinarily be estimated from data in the city; the values here are derived from existing systems or assigned plausible values. Processing, collection, and household parameters are defined.

68-0153

Schultz, G. P. The typical facility and service area. *In* Managerial decision making in local government; facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968, p.118-180.

A method is developed for choosing the optimal capacity and location for a typical transfer station and the optimal size and shape of its service area. An optimization model to produce a solution for a city in which household density and solid waste output are uniform over space and unchanging through time is proposed. The principal conceptual device used is the statement of each component of average annual cost per household as a function of the radius of a circular service area. An optimal solution can be found for each facility capacity if the sum of the component cost functions is a "U-shaped" function of the service radius, that is, if the minimum value occurs at some point between zero and infinity. Under conditions of an isotropic transport system and uniform household distribution, the optimal service area form will be a circle centered on the facility. Using this form of service area, the facility, processing, and collection costs are determined, and the methods and functions used are given. Numerical examples were used to compute costs for all facility capacities from 1 to 20 and for service radius increments of 125 miles to 10 miles. Figures show the total annual cost per household for facilities having 2, 5, 10, 15, and 20 bays, assuming previously determined parameter values. Costs for the optimal solution and the quantities of

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other physical inputs and outputs of the system are determined. Direct and indirect haul zones are defined. The number of facilities required can be approximated by dividing a zone area by the optimal service area.

68-0154

Schultz, G. P. The facility location pattern. *In* Managerial decision making in local government: facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968. p.151-180.

The facility location pattern is determined by minimizing collection costs—the problem being to place facilities where the sum of the distances from each household to the nearest facility is minimized. An hypothetical city having an irregular distribution of households and an average density of 3,500 households per sq mile is proposed. The typical service area previously defined is used to estimate the approximate number of facilities needed, and a location algorithm is used to define specific facility locations and service area boundaries. An optimal location pattern will be a partial equilibrium solution, in that no further change in location of transfer stations or service area boundaries will result in a lower cost per household. For the modified Maranza location algorithm used, the theory is defined and the application and parameters used in its application to this problem are considered. Printouts show examples of the Household Distribution map, location patterns, and a Final Service Area Map. Also included is an information table giving the coordinates of each facility, the number of people served by each, and the collection cost per household for the facility. Costs for various numbers of facilities and costs for each service area are tabulated.

68-0155

Schultz, G. P. The facility timing strategy. *In* Managerial decision making in local government: facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968. p.181-226.

A facility timing strategy is a set of decisions concerning the initial size of each facility, the size of increments to these facilities, and the times at which they would be built. The optimal timing strategy results in the lowest cost per household over a relatively long planning period. Proposed models on facility timing are considered, and the effects of long-run and short-run strategies on the urban planning level examined. When the household distribution is largely fixed early in the planning period, the facility location pattern should be based on the distribution for a time early in the period. Functions considering the expansion in demand and costs are given. Models developed include forecasts of demand as a function of time and measure the costs of excess capacity and excess demand. A product inventory model is designed to determine the optimal number of items to produce per production run and the optimal interval between runs, as developed for manufacturing situations. A facility inventory model is proposed which can be applied to the timing of construction of increments when the demand is increasing at a constant rate. Another model, which requires the assumption that facility locations and service areas are fixed but could allow the introduction of changes in a number of parameters, is also proposed.

68-0156

Schultz, G. P. Conclusion. *In* Managerial decision making in local government: facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968. p.227-249.

The anticipated expansion in public services suggests that there will be an expansion in solid waste collection as well. A study of the transfer facility method of solid waste collection to discover a rationale for facility planning for a solid waste collection system and to devise an operational decision model consistent with the rationale may, therefore, be useful. A serious attempt has been made to describe the important decisions needed and to adapt methods to these problems. The decision model which has been developed consists of several submodels, each of which provides a proximal solution for a subset of the decision variables. In applying the model to the hypothetical city proposed, it has become apparent that: the direct costs of domestic solid waste collection for a city are significant when compared to costs for other urban services; the part of solid waste collection costs directly attributable to facility capacity, location, and timing is relatively small compared to pickup costs; and the sensitivity of costs to small changes in the value of facility planning decision variables is low.

68-0157

Schultz, G. P. Appendix A. *In* Managerial decision making in local government: facility planning for solid waste collection. Ph.D. Thesis, Cornell University, Ithaca, N. Y., Jan. 1968. p.240-247.

Before establishing an optimal location pattern for transfer stations, it is necessary to know the time required for collection vehicles to travel between potential facility sites and the sub-areas of the city which might be in its service area. It is necessary to discuss the general nature of network problems before describing an algorithm for determining the shortest route. These definitions and functions are given. The Dantzig Shortest Route Algorithm is detailed and a numerical example provided. The information provided in this section is necessary to establish the optimal location pattern for transfer stations.

68-0158

Sheffield's driver training scheme. *Public Cleansing*, 58(3):115-119, Mar. 1968.

When the policy was changed and it was envisaged that the majority of vehicles for refuse collection would be driven by petrol or diesel instead of being electrically propelled, a driver training course was instituted. Special apparatus, pictorial methods, lectures, and discussions were used to teach the principles of water cooling systems, gears, hydraulics, and driving. The lectures included the operation of the electric vehicles for new drivers. A 32-question examination concluded the course.

68-0159

Skornyakova, R. Kh. Efficiency of regular direct garbage removal in Novorossiisk. *Hygiene and Sanitation*, 33(1-3):431-433, Jan.-Mar. 1968.

Daily garbage removal in Novorossiisk is effected by having a garbage truck arrive at fixed stations at regular times each day so that the inhabitants can carry and discharge garbage at the trucks. The garbage is removed in trucks of the type M-93 (with a volume of 6.5 m) and each truck has a driver and a laborer. The system required extensive preparatory and explanatory work and was introduced in gradual stages. The system resulted in the utilization coefficient of the trucks going from 0.68 in 1960 to 0.82 in 1965. The size of the crew was reduced from 3 to 2 and 30,000 rubles were saved which were formerly needed for sanitation and maintenance of garbage bins. Flies and rodents were reduced, and soil and air pollution eliminated. Household refuse from public spaces and restaurants, etc., is removed in bins and clean bins are substituted each day. The area served by this plant has a population of approximately 120,000.

68-0160

Suspended rail crane for the transportation of refuse. *Elektrizitaetswirtschaft*, 67(18):553, Aug. 1968.

Nofit-Transportautomatik, Aulendorf (Wuerttemberg, West Germany) bought a suspended rail crane for the transportation of domestic, industrial, and bulky wastes to the market. The crane is suspended either on single or double rails. It is able to carry 500 to 2,500 kilopounds of waste. If it is suspended on double rails, it is capable of lifting its load up to 20 m, with a speed of 15 m per minute. The crane travels with a speed of 40 to 50 m per minute along the rails. The lifting and driving motors are optionally designed either for 48 volts or for 380 volts three-phase current at 50 Hz. The rail system can be equipped with automatically controlled switches. The control of the entire system is either partly or fully automated, or it can be controlled by a computer. The crane brings the wastes from the trucks to the storage bunker or directly to the incinerator or the composting plant. (Text-German)

68-0161

Taylor, A. British local authorities' example for overseas buyers. *Surveyor and Municipal Engineer*, 132(3990):34-37, Nov. 23, 1968.

British cleansing appliance manufacturers have long been exporting equipment of standard design and equipment where specifications have required some amendment to meet special local circumstances. Actual examples of service to overseas markets include: bulk refuse compaction trailers; Dumpmasters for refuse collection; road suction and mechanical sweepers; and gully emptiers, cesspool emptiers, and dual-purpose units. Anti-corrosive treatment both for bodies and body frames is often necessary. Illustrations of some of the vehicles available for export are included.

68-0162

Tope, O. Vehicle and equipment exhibition of the Association of Communal Waste Disposal and City Cleaning Departments in Saarbruecken (1968). *Staedtehygiene*, 19(12):280-287, Dec. 1968.

On June 26, 1968, the largest exhibition of the Association of Communal Waste Disposal and City Cleaning Departments

was opened. Numerous waste disposal trucks were on display, the largest of which had a capacity of 28 cu m. One truck had a two-stage compactor which reduces the volume to one-fourth. Generally, all disposal trucks showed a trend toward better compaction and faster and simpler loading. One displayed wreckage compactor could compress a car body to 20 percent of its original dimensions. All known types of cars and small trucks can be compacted with it. A waste crusher was displayed, that was capable of reducing volumes by 50 to 70 percent. Several trucks for cleaning canal system were also shown at the exhibition. New street sweepers which wash away the dirt underneath parked cars and brushes which loosen dirt with high pressure water jets and subsequent vacuuming were shown. The used water is recovered by cleaning it with a filter. This method is highly controversial since toxicants and bacteria are distributed over the entire route. Multi-purpose vehicles for collecting street and market dirt, sand, soil, oil, etc., which are already in use in the United States were introduced. Almost all types of waste incinerators were on display. The importance of careful waste gas cleaning was stressed, since plant injuries were observed recently in the vicinity of incinerators. A waste and sludge composting plant with incineration of the residues was shown. (Text-German)

68-0163

Truitt, M. M., J. C. Liebman, and C. W. Kruse. User's guide to the simulation model (model 3 of volume 1). In *Terminal report of an investigation of solid waste collection policies*, v. I & II. Baltimore, Johns Hopkins University, Department of Environmental Health, Aug. 1968. 23 p.

Instructions to the user for operation of the model are included. Fourteen variables are under the user's control. Among these are: collection frequency, truck capacity, location of transfer station, location of disposal site, and the real urban tract for which the model simulates a collection system that may be bounded, as desired by the user, with a maximum population constraint of approximately 300,000 people. The system control card, which is the next to the last card in the entire program and upon which are punched nine variable values which control system policies to a large extent, is described. The variables individually considered and the columns in which the values must be typed are indicated. The geographic information required for that subprogram is specified and examples of data collection and use in the subprogram are given. The field performance information and cost variables and the manner in which their values are presented are also discussed. Computer requirements and output are considered.

68-0164

Truitt, M. M., J. C. Liebman, and C. W. Kruse. A survey of pertinent literature. In *Terminal report of an investigation of solid waste collection policies*, v. I & II. Baltimore, Johns Hopkins University, Department of Environmental Health, Aug. 1968. p.13-24.

The survey of pertinent literature is divided into two major parts. The first is based on a survey of publications of the collection practices in America, and the second deals with literature concerning digital computer simulation. Both sections deal primarily with very recent literature. Each

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reference is given a brief abstract relating to the sections of interest in the development of this report. The first section contains 13 references and the second, 14 publications. The latter references are not necessarily related to solid waste, but contain approaches and discussions relating specifically to other topics that are nonetheless relevant to this publication. Work which specifically applied digital computer simulation to municipal solid waste collection was done at Northwestern University by Quon et al., 1965.

68-0165

Truitt, M. M., J. C. Liebman, and C. W. Kruse. The policies and structures of models 1 and 2. In Terminal report of an investigation of solid waste collection policies, v.I & II. Baltimore, Johns Hopkins University, Department of Environmental Health, Aug. 1968, p.25-49.

The purpose of Model 1 is to determine the collection potential and associated costs of a collection truck operating under a set of stochastic conditions within the framework of an 8-hr work day. The model simulated the fielding of 180 collection trucks and each was ascribed a constant neighborhood density. Other variables held constant for individual runs are: number of days since last collection, collection frequency per week, season, truck capacity, and size of crew. On each run the Model was programmed so that groups of 30 trucks each were sent to six different collection areas, each area being a different distance from the final disposal sites. Tabulations are included of some runs and actual selections of controllable variables. Flow charts are included for the principal subroutines of Model 1. Model 2 is essentially Model 1 with a policy change in that each of the 180 trucks is given a definite task assignment of some number of households from which to collect. No decision making is programmed into Model 2 to determine if another trip should be made; the only question asked is if all units have been served. The controllable variables and the subroutines which differ from Model 1 are shown. A general schematic of the two models is included, and a more detailed figure is given showing the interaction of the main program with the 33 subroutines.

68-0166

Truitt, M. M., J. C. Liebman, and C. W. Kruse. Fortran IV coding of the simulation model. In Terminal report of an investigation of solid waste collection policies, v.I & II. Baltimore, Johns Hopkins University, Department of Environmental Health, Aug. 1968, p.25-69.

The computer program is in the FORTRAN IV language and was run under an IBSYS monitor on an IBM 7094 computer. The installation consisted of an IBM 1401 RAMAC system (used as a slave to the 7094) and a 7094 equipped with two data channels with eight tape drives per channel, a printer, and a card reader. An average run required 3.90 minutes. The model should run equally well on any electronic data processing system having a FORTRAN IV compiler, an input/output device, and at least 20,000 words or equivalent of core storage. The FORTRAN IV coding of the simulation model is reproduced on 42 pages.

68-0167

Truitt, M. M., J. C. Liebman, and C. W. Kruse. Results from models 1 and 2. In Terminal report of an investigation of solid waste collection policies, v.I & II. Baltimore, Johns Hopkins University, Department of Environmental Health, Aug. 1968, p.50-75.

The results from Models 1 and 2 for the number of housing units serviced by a truck per day is indicated graphically and tabulated for various runs. The sensitivity of responses to random number sequences from three successive runs is tabulated and graphed. Six runs made to determine the effect of season on collection indicated that there were no statistically significant differences in the collection rates, but they did indicate a significant difference in lb per person of waste generated. Some results from these runs are tabulated and graphed. A cost comparison of semiweekly and triweekly collection frequency indicated a longer average workday and a greater average tonnage for the first collection days than for the last. The unit costs of semiweekly and triweekly service by neighborhood type are given graphically. A five-way analysis of variance study was made to determine the significance of different variables on the cost in dollars per ton of the entire collection operation. The variables were: capacity of trucks, density per acre of housing units, seasonal conditions, days since last collection, and haul distance. The percentage of worktime spent by trucks in different activities during the day is illustrated by average values from two runs given both in graph and table form. Runs were also made to secure results from comparison of dollars per ton costs of semiweekly collection. Graphically, the curves decrease asymptotically in the direction of increasing task assignments.

68-0168

Truitt, M. M., J. C. Liebman, and C. W. Kruse. The policies and structure of model 3. In Terminal report of an investigation of solid waste collection policies, v.I & II. Baltimore, Johns Hopkins University, Department of Environmental Health, Aug. 1968, p.76-114.

A sample is given of results from a run of Model 3. A run simulates the activity of 20-cu-yd collection trucks in a particular area for one week. Model responses include the week's costs in dollars per ton of the collection trucks's operation, of the transfer station operation and of their sum. Mileage figures, distribution of overtime, summation of trips made, tonnage by days, costs by days, and average length of working days are presented. The general limitations of this Model are that only one transfer station can exist. Only one final disposal site, and one size of collection truck and haul vehicle can exist. However, each of these may be changed with different runs. Seven policy decisions must be made: the extent of the area to be investigated; frequency of collection; size of collection trucks; size and type of transfer stations; its site and routes to it; the final disposal site and routes to it; and overtime pay. The actual model structure may be thought of as being divided into three blocks: the model accepts policies, initializes variables to proper values, and carries calculations for truck assignments by days of week. The simulation of 6 days' activities is made with summaries of system responses at the end of each day, a summary of the entire week's activity is made and applicable calculations

carried out, and the system responses are listed. The subroutines are listed and described, and flow charts are given.

68-0169

Truitt, M. M., J. C. Liebman, and C. W. Kruse. Conclusions and summary. In Terminal report of an investigation of solid waste collection policies. v.I & II. Baltimore, Johns Hopkins University, Department of Environmental Health, Aug. 1968. p.135-152.

Some limitations of the present study include lack of actual operating data in some areas and defects in the neighborhood classification system. The model proving runs gave figures slightly above those actually found by the city but the differences were easily attributable to random number sequences and variations in the real system. They indicate a fairly accurate model. The disposal site and transfer site planning costs may be determined by the model. The critical haul distances for transfer station feasibility indicate that the station will be equally desirable if the frequency of collection is semiweekly or triweekly. The equipment, planning, effects of queuing, and the number of trucks and their assignments are analyzed. The results from Models 1 and 2 serve primarily as a basis for Model 3, but they also gave insights into the relation of relative costs of tri-versus semiweekly collection. The semiweekly collection system was the more costly, primarily due to the time and mileage in the collection neighborhood; however, the triweekly collections averaged shorter workdays.

68-0170

Truitt, M. M., J. C. Liebman, and C. W. Kruse. Appendix A-E. In Terminal report of an investigation of solid waste collection policies. v.I & II. Baltimore, Johns Hopkins University, Department of Environmental Health, Aug. 1968. p.153-216.

Appendices A through E contain, in order, data from the City of Baltimore; data other than Baltimore; data gathering forms; cost calculations for semiweekly and triweekly collection; and results from Model 3. The data of the City of Baltimore includes equipment in operation, waste generation by month, monthly variation in solid waste production (5 year average), traffic analysis, tests for significance of neighborhood type and collection frequency on collection rates for four neighborhood types, assumed collection rate, speeds, analysis of dumping procedures, and incinerator service times. Further data were gathered for the purposes of this study. Data from cities other than Baltimore included information on existing transfer station operations and costs. Data gathering forms used for collecting traffic speed and collection speed data are included. Cost calculations for semiweekly and triweekly collection and the results from Model 3 are in the form of tabulations of various runs.

68-0171

Vondrak, G. H. Transfer station shrinks the dead haul. American City, 83(2):100-101, Feb. 1968.

The City of Dearborn, Michigan, uses 60-yd compacting trailers to haul its refuse from a transfer station to a refuse-disposal site 26 miles away. The transfer station is equipped with three hoppers and an opening for a fourth. Each hopper is independently powered by a stationary Hobbs Hyd-Pak power unit that adjoins it at the upper level. Down below, 60-yd compaction trailers are parked under each hopper, waiting for the loads of refuse that are discharged above the collection packers. The collection trucks back into the upper level of the station and discharge the refuse into the hoppers which each hold 20 cu yd. Hydraulically powered sliding bulkheads at the bottom of the hoppers control the transfer of the refuse to the big trailers. Stationary pumps run by electric motors send hydraulic fluid through quick-connect hoses attached to the trailers, activating the hydraulic cylinders, and thereby moving the packer plate inside each trailer. The packing plates exert 111,000 lb of pressure, compacting refuse to upwards of 700 lb per cu yd. Each trailer is equipped with a load ejection system to discharge the load at the disposal area.

68-0172

Waste transport by suction--a hygienic improvement. Staedtehygiene, 19(12):4, Dec. 1968.

Centralsug GmbH, Hamburg, West Germany, offers a new suction transport system for rubbish and other types of waste accumulating in hospitals, office buildings, and apartment houses. Transport by suction has been introduced in Sweden where such a system has been installed in hospitals. In Sundbyberg, a suburb of Stockholm, this transport system has come to replace waste disposal trucks. The transport of soiled laundry and wastes by suction requires less personnel than the common waste collection system by trucks. The system operates automatically. Through a pipe system with valves in floors and walls, the waste can be sucked into the incinerator installed in the basement of a building (hospital, apartment house, etc.). The operating costs of the system are low since all exhausters operate only while something is transported. (Text-German)

68-0173

Wilson, D., and J. A. Freaney. Appendix E. Comparison between alternative collection methods. In Summer study on the management of solid wastes; final report. v.I. Cambridge. Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. p.40-41.

Rough calculations are presented to show some of the advantages obtainable by automating the pickup system. Marginally lower costs for the home-compaction system over the paper-bag system were found, but this difference is not significant; all values assumed in the calculation are highly variable. Paper bags show no high costs and considerable fringe benefits in conventional collection provided that high-speed packer trucks are used. A five-alternative chart vs. costs is presented.

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68-0174

Wolf, K. W. Rail haul as an integral part of waste disposal systems. In *The affluent and the affluent. Waste management—problems and prospects*. Chicago, Railway Systems & Management Association, 1968. p.39-52.

A description is given of the work being done by the Research Foundation of the American Public Works Association on rail haul of solid wastes, partially financed by the Solid Wastes Program of the U.S. Public Health Service. Solid waste disposal involves a mass market requiring the adaptation of techniques used in mass production, as well as those used in the transportation and handling of large volumes of materials. Operational and marketing factors of the solid waste disposal field are reviewed. The rail-haul system is viewed as being in competition with other disposal systems such as incineration, composting, and sanitary landfill. The most dangerous competitor for the rail-haul system is the local landfill and the collection truck trailer transfer approach. It is estimated that rail haul should not cost more than a maximum of \$4.50 per ton. Rail transport might pursue three functions: transport gathering and accumulation of the materials, i.e. train assembly from different origin points and storage. Shipping densities for rail haul are estimated at about 2,000 lb or one ton per cu yd. Shredding costs are estimated at \$0.80 to \$0.90 per ton, and compacting at \$1.73 to \$2.60 per ton. Calculations of transfer station operations suggest a goal of \$1.00 to \$1.50 per ton. Rail haul combined with compaction and land reclamation provides numerous advantages which might change the attitudes of people towards wastes from other areas.

68-0175

Wolf, K. W., C. Sosnovsky, and V. Babich. The potential benefits of rail-haul as an integral part of waste disposal systems. In *Engineering Foundation Research Conference: Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. A-3.)

Findings to date from the American Public Works Association rail-haul study indicate that the compression and/or baling of refuse is the most effective and economical way for handling wastes in a rail-haul system. The benefits of waste rail haul are: possible cost of \$4 per ton; reduction of air and water pollution; capability for land reclamation such as worthless mining land; relative immunity to weather conditions and damages to part of the system; and applicability to large and small communities. It is recommended that the States actively consider the establishment of suitable disposal sites in terms of waste rail haul.

68-0176

Zandi, I. Collection and removal of municipal solid wastes by pneumo-slurry system. *Compost Science*, 9(2):7-11, Summer 1968.

In the pneumo-slurry system the solid waste will be collected from points of origin to a few central locations via vacuum lines. At these central points the waste will be presized with

the aid of crushers, mixed with a small percentage of waste water of the community, and dumped out to the point of disposal. Studies indicated that the task of collecting and removing solid waste in a pneumo-slurry system can be accomplished with the present technology. Slurries up to 12 percent solids by weight have been pumped. Over a period of 50 years, the combined pneumatic and slurry pipeline transport of solid waste will be less expensive than truck collection if solid waste has to be transported a distance of 50 miles or more to the point of disposal, as is presently proposed in the City of Philadelphia. There is already some useful information available concerning wet oxidation which points to the usefulness of this method for the disposal of solid waste slurry.

68-0177

Zandi, I. Pipeline collection and removal of domestic solid wastes. In *Engineering Foundation Research Conference: Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. A-2.)

Research on the feasibility of pipeline transport of solid waste and an economic comparison of pipeline and truck collection are being carried out. Pneumatic transport of domestic solid waste is possible and normal household solid waste can be crushed to proper size for piping. Solid waste slurries with concentrations up to 12 percent by weight are already conveyed through pipes. Under certain conditions, the combined pneumatic and slurry pipeline transport of solid waste will be less expensive than truck collection over a period of 50 years if solid waste has to be transported a distance of over 50 miles. A reasonable advance in the technology of crusher-pump units will make the pipeline system more economical than truck collection even for shorter hauls. An extension of the economical comparison to two different communities is under way.

68-0178

Zandi, I., and J. A. Hayden. Collection of municipal solid wastes in pipelines. Presented at Transportation Engineering Conference, American Society of Civil Engineers, San Diego, Feb. 19-23, 1968. 43 p.

According to the American Public Works Association, the disposal of solid waste is now the toughest problem in the field of public works. Pipeline transport of solid matter is already a well developed technology in several industries and it would seem, therefore, to be acceptable for the collection of solid wastes. The pipeline systems used are pneumatic transport, slurry carries and a combination of both. The list is already a reality. In Sundbyberg, Sweden, a vacuum-sealed pipeline installed in a 250-apartment complex sweeps the solid waste along in an airstream to an incinerator 1.7 miles away. This installment has worked very satisfactorily. Since there has been no previous experience with solid wastes in slurry pipelines, an experimental model was built as part of the project's research. In this system, the refuse has to be

ground to small particles before being injected into the pipeline to be carried to its destination by the carrier fluid. This system, although not yet fully perfected, was found to be feasible. Monetary aspects are not clear, because there are not enough systems on which to base any data. However, projected cost is figured and is presented in tables along with graphs and figures explaining the pipelines.

DISPOSAL

68-0179

Adam, R. Problems of waste disposal in the USA. *Wasser Luft und Betrieb*, 12(3):162, May 1968.

To the many problems of American cities is added a most difficult one, that of eliminating wastes. Disposal sites have become scarce and, if the waste is incinerated, air pollution is increased. About 6 to 8 lb of waste per inhabitant accumulate daily, twice as much as 20 years ago. Dumping is the most common method of disposal but cities are searching for new ways. Washington, D.C., for instance, wants to close an incinerator on its outskirts because it contributes greatly to air pollution. Philadelphia signed a contract a short while ago to transport 1,200 tons of waste per day to abandoned mines in Pennsylvania. Washington, D.C., will probably use the same solution. Nine counties in the San Francisco Bay area dump 60 percent of their waste into remote sections of the bay, but a commission of the State of California has decided against this solution. In Boston, there is now a plan to construct a large boat with an incinerator on board. The residues from incineration will be dumped far out in the ocean. The City of New York is in an especially bad situation. Almost all wastes are burned. In addition to municipal incinerators, there are about 2,000 smaller ones in apartment houses. If only 40 percent of those stopped incineration, 800 trucks would be required to transport the waste. Also, when a sanitary disposal site is selected complaints come from as far as 15 miles from the site. The collection, transportation, and elimination of 1 ton of waste costs \$30 in New York, three times the cost of transporting 1 ton of coal from Virginia. For the entire United States, the cost of dealing with 165 million tons of waste per year is \$3 billion. Los Angeles is considered lucky, because it has numerous gorges in the mountains nearby where waste can be safely dumped. The grinding and composting of waste is less common because the produce cannot compete with chemical fertilizers. (Text-German)

68-0180

Anderson, J. From the editor. *Virginia Health Bulletin*, 20(10):1-14, Feb. 1968.

The mounting refuse problem makes it imperative that communities develop clean and aesthetic methods of refuse disposal. With present technology, there are two methods of disposal which are acceptable from a public health standpoint, sanitary landfill and incineration. Salvaging and composting hold great promise for the future. Landfill guides set the following standards: sufficient land to provide a disposal site for many years; reasonable haul distance from source and all-weather access to the site; sufficient and suitable cover material; no danger of polluting ground or

surface water; a secluded area; a plan for use of the land after landfill completion; cooperative use with neighboring communities if possible; adequate amount of the right equipment; refuse covered at the end of each day with 6 in. of earth/and at the completion of the f.l., covered with 2 ft of earth; intermediate cover on all cracked or eroded areas on a weekly basis; maintenance and operation of fill by qualified personnel; no burning of refuse or garbage allowed; and provisions for insect and rodent control when necessary. Incinerators, although acceptable, cost large sums of money and increase cost of refuse removal. They cannot handle unburnables, which creates the need for dual collections and disposal of incinerator ash. The plans and specifications of an incinerator should be prepared by a qualified registered engineer and operated and maintained under the direct supervision of a person qualified by experience and/or special training in the field of incinerator management.

68-0181

Arnst, F. Garbage disposer. *Staedtehygiene*, 19(6):124-125, June 1968.

The garbage disposer is generally installed in the kitchen sink of households and hotels. Its main advantage is hygienic and fast elimination of all organic and putrescible wastes. Many authorities reject its use because they fear that it will overstrain the canal system. This fear, however, is unfounded. According to regulations, each canal system must be able to take a 30 percent load of sand, which poses a much greater problem, since sand is heavy and settles to the bottom. Pumps and all sorts of canal dredging units must be used to prevent any clogging. Organic substances, however, remain suspended in the water and are carried away instead of remaining in the canal system. Moreover, they activate sewage sludge. The amount of organic waste washed down the drain from the garbage disposer is also very often overestimated. From the 3 liters of waste accumulating per capita only 5 percent is organic matter, while water consumption is about 200 liters per capita daily. However, not everyone can afford a garbage disposer. Considering all this, there is no reason to reject the disposer. The amount of inorganic matter is usually very low, so there is no need for closer study of the problem of abrasion. Strangely enough, waste collectors are opposed to the garbage disposer because of a ridiculous fear that the wider use of it takes away their jobs. They ignore the fact that only wet and putrescible material which actually poses the greatest problems to the waste collector (freezes in winter, smells in summer) is eliminated by the disposer. (Text-German)

68-0182

Bergling, S. Lulea refuse incineration and sludge-drying plants. *Public Cleansing*, 58 (4):192-199, Apr. 1968.

Since 1950, the yield of refuse per person in Sweden has increased 5 to 10 percent. Since the existing refuse tip in Lulea can only be used until 1970, and new sites are difficult to find, a refuse incineration plant was decided upon. Refuse will be transported by truck and tipped into a reception pit capable of storing refuse for at least 3 days. Connected to the pit will be a power-operated device for breaking up bulky waste. The plant's two furnaces will have a refuse capacity of 6 tons per hr each. Each furnace is provided with a flue-gas

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cleaner for wet separation, designed as a cascade scrubber. A sewage treatment plant, nightsoil treatment plant, and a destruction plant for waste oil are being built at the same place as the incineration plant. It will be possible to use the heat of combustion from different operations for drying the sewage sludge in rotary dryers, as well as to burn waste oil products in the refuse furnaces and in the sludge-drying plant. The construction cost of the refuse incineration plant, combined with the drying plant for sludge, is estimated to be about 5 million Swedish kroner.

68-0183

Black, R. J., A. J. Muhich, A. J. Klee, H. L. Hickman, Jr., and R. D. Vaughan. The national solid wastes survey; an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 53 p.

The interim report consists of five papers, each presented at the 1968 Annual Meeting of the Institute for Solid Wastes of the American Public Works Association, Miami Beach, Florida, October 24, 1968: 'The Foundation Provided by the New National Data' by Ralph J. Black, Deputy Chief, Solid Wastes Program, Environmental Control Administration, Consumer Protection and Environmental Health, Public Health Service; 'Sample Representatives and Community Data' by Anton J. Muhich, Chief, Systems and Operations Planning, Solid Wastes Program; 'The Role of Facilities and Land Disposal Sites' by Albert J. Klee, Chief, Operational Analysis, Systems and Operations Planning, Solid Wastes Program; 'The Challenge That The National Survey Presents' by H. Lanier Hickman, Chief, Technical Services, Solid Wastes Program; 'National Solid Wastes Survey, Report Summary and Interpretation' by Richard D. Vaughan, Chief, Solid Wastes Program. The information presented is preliminary in that it represents partial fulfillment of a national solid waste survey scheduled for completion in 1971.

68-0184

Breidenbach, A. W., H. L. Hickman, Jr., and J. DeMarco. The potential role of analytical chemistry in solid waste technology. [Cincinnati], U.S. Department of Health, Education, and Welfare, [1968]. 13 p.

A paper presented at the Twelfth Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tennessee, Oct. 1968. The problems of sampling and analyzing solid wastes, the challenge that is before the field of analytical chemistry, what is currently being done in the field, and what must be accomplished in the field of analytical chemistry are discussed. Data charts are furnished by the Bureau of Solid Waste Management on physical characteristics and geographical distribution of municipal solid wastes. Other areas of present need involve the development of field measuring devices to help overcome the problems of sampling. This is a major accomplishment in other environmental pollution fields. Moisture determinations in the field would be an improvement. Gases must be measured and monitored in place, and water leachates that can contain more varied substances than those found in industrial or municipal waste waters will need monitoring. A broad challenge exists because of our limited knowledge about the chemical composition of solid waste.

68-0185

Buell, D. Regional plans needed for future--solid waste disposal--I. Congressional Record, 114(42):S2843, Mar. 14, 1968.

Protesting odors, rodents, and pollution, Saugus, Massachusetts', citizens picketed the DeMatteo dump. John O. Stinson, Ipswich town manager and former Saugus town manager, said the cost of dumping must include cost of putting out fires, damage to equipment, depreciation of real estate, and discomfort of neighbors. A ton of refuse disposed in a sanitary landfill costs \$3.00 to \$3.50, compared to \$7.00 to \$10.00 in an incinerator, but incineration is necessary for densely populated urban areas. Larger tonnage in regional disposal should result in cheaper costs. Incineration at sea is under study at Harvard University. New high-heat incinerators may be able to produce residues satisfactory for road fill. Areas are experimenting with combining incineration with production of steam, electric power, and desalinization of sea water.

68-0186

Buelow, R. W. Ocean disposal of waste material. In Transactions: National Symposium on Ocean Sciences and Engineering of the Atlantic Shelf, Philadelphia, Mar. 19-20, 1968. [Washington], Marine Technology Society. p.311-337.

Studies by the Northeast Marine Health Sciences Laboratory of the two main sewage sludge dump areas, the New York Bight serving the New York Metropolitan Area and a site off Delaware Bay serving Philadelphia and others in the Delaware River region, were planned to aid in defining the problem and in planning future investigations. Emphasis was given to the spread of bacterial contamination caused by the discharge of sewage sludge. Shellfish are capable of concentrating and holding bacteria, viruses, and toxic substances which can be transmitted to consumers of the shellfish. The quantity of sewage sludge disposed of at present is approximately 12,600 cu yd per day in the New York Bight and 1,400 cu yd per day off Delaware Bay. The results of the investigation showed that there was a rapid decrease in the coliform indicator. Samples taken in the wake of a discharging barge resulted in total coliform MPN of 150,000 per 100 ml for the Delaware Bay Study and in excess of 2,400,000 per 100 ml for both fecal and total coliforms in the New York Bight Study. There was considerable sludge covering the bottom of the New York Bight disposal area. This is detrimental to production of surf clams. The bacteriological data indicate that a well regulated sewage sludge disposal program would not cause widespread bacterial contamination. High concentrations of copper were found in seawater samples collected in the New York Bight Acid Waste Dump.

68-0187

Burchinal, J. C. A study of institutional solid wastes; an interim report. Morgantown, West Virginia University, 1968. 15 p.

The specific aims of the study are to: determine the physical and chemical composition of the solid wastes from one medical school and hospital complex; determine whether bacteria and viruses are present to any significant degree in the waste; provide a classification basis and obtain quantity

values for the wastes of various departments; establish a safe procedure for studies on potential pathogenic wastes; provide information about solid wastes that can be used by designers of medical complexes; and develop a sampling procedure which could be used in future studies. Various methods of solid wastes disposal and volume reduction are utilized within the Center. These included incineration, burial, selling, and discharge to the sanitary sewer. Radioactive wastes are disposed of by periodic burial. The design of sampling and weighing procedures to obtain weights, estimated volumes, types, and generation origins of solid wastes within the entire center is outlined. The total cost of refuse handling and disposal comes to \$77,280 per year and using a rough approximation of 1,000 tons of refuse generated per year, this gives a cost of \$77.28 per ton. Solid wastes, generated by the different portions of the hospital for given dates, are tabulated. Sampling data is placed on format sheets for card punching so that the computer may be used to analyze the data.

68-0188

Bury meets new law with Edbro Bucket Loader. *Public Cleansing*, 58(7):354-356, July 1968.

In compliance with Part 3 of the Civic Amenities Act, effective July 27, 1968, which obliges local authorities to provide convenient sites for household refuse, and to dispose of vehicles abandoned on or near the highway, the Bury Corporation Cleansing Department in Lancashire has utilized an Edbro Bucket Loader mounted on a Dennis Paxit V 12-ft wheelbase chassis. The Edbro hydraulic materials-handling equipment is being used with 10 buckets as mobile refuse dumps, and without the buckets to lift and carry derelict vehicles. The buckets are situated at strategic locations based on street-sweepers' operating areas, and every householder is within a mile of a dump. The buckets are emptied when necessary. Buckets are also being used at the department's refuse-disposal plant, both as receptacles for articles which will not go through the separation equipment, and to collect dust and cinders from the hoppers. This second application used roller jacks. Buckets will be used in the future for large household pickups. Other uses of the vehicle and its lifting equipment are discussed.

68-0189

Calhoun, F. P. Avoiding pollution from refuse disposal. *Mining Congress Journal*, 54(6): 78-80, June 1968.

Refuse piles cause a pollution problem as well as an eyesore when abandoned. Every refuse pile has its own peculiarities, and no single formula can be developed for all conditions, although adhering to a few basic principles will eliminate air and water pollution problems. A suitable site should be conveniently located and be able to hold at least 10 years' production of refuse. How to use the area without causing pollution should be determined. All vegetation should be removed before covering the area with refuse, maintaining a cleared area at least 50 ft beyond the refuse. Diversion ditches to prevent surface runoff water from entering the refuse must be provided. A trench should be dug along the lower edge of the area to key the refuse into stable ground and to prevent slippage of the pile. Refuse should be spread in layers 2 to 4 ft thick, and should be thoroughly compacted

to avoid the entry of water and air and to prevent spontaneous combustion. Sides of the pile that extend above ground level should be covered with at least 2 ft of top soil. The sides should be terraced at 10-ft intervals with an 8-ft flat area and a 35-degree slope between terraces. When a pile is to be abandoned, the top surface should be covered with 2 to 3 ft of top soil and planted. Vegetation improves appearance, prevents erosion, and reduces drainage from the pile.

68-0190

Chapman, R. A., and C. J. Rogers. Hydrolysis of municipal refuse. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, H. Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. H-2.)

A spectrophotofluorometric method is being used to determine the quantities of glucose and furfural produced from the cellulose in polymeric materials in the presence of acid, high temperature, and pressure. Four variables will be considered in optimizing the hydrolysis process: temperature of the mixture, acid concentration, sample concentration, and time of reaction. Once the process is optimized using pure cellulose, mixed samples of paper found in municipal refuse will be hydrolyzed. Other subjects under investigation are: utilizing sugars to grow microorganisms for high quality protein livestock feed and the production of polyesters, and the utilization of straw and grain hulls to produce furfurals, chicken feed, and cattle feed.

68-0191

Corps of Engineers studies alternative dredging waste disposal. *Environmental Science and Technology*, 2(3):169, Mar. 1968.

Diked disposal areas offer possibilities for the disposal of polluted harbor dredgings, according to Brigadier General Robert M. Tarbox, U.S. Army Corps of Engineers. At the recent Lake Michigan Water Pollution Enforcement Conference, Gen. Tarbox stated that a 4-year program for the construction of such areas at the 15 most critically polluted harbors of the Great Lakes would cost \$95.5 million in construction costs for the dikes, plus an additional annual cost for harbor maintenance, according to Corps estimates. For more than 40 years, the dredged material has been placed in authorized disposal areas in deep waters of the Great Lakes. In accord with current U.S. policy, disposal areas for retaining dikes must be provided at local expense as part of the local cooperation required for the projects. Eight localities are presently working with the Corps, and other possibilities such as disposal in pits and mines are being considered.

68-0192

Day and Zimmermann, Inc. Population growth. In *Solid waste disposal report for counties of Manatee and Sarasota, Florida*. Philadelphia, Pa., 1968. p.24-27.

The combined population of both counties is expected to be 323,500 in 1980. This represents a total increase of over 1½ times the current combined population. The population centers of both counties are expected to remain in a 5 mile

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wide strip of land bordering the Gulf of Mexico. This represents a north-south growth pattern in each county resulting in a continuous urban corridor stretching from Palmetto in Manatee County to Englewood in Sarasota County. No significant changes are expected to result in the industrial climate for either county prior to 1980. With the development of a deep-water port at Port Manatee the industrial picture could change, but this is not anticipated until after 1980.

68-0193

Day and Zimmerman, Inc. Solid refuse generation. In Solid waste disposal report for counties of Manatee and Sarasota, Florida. Philadelphia, Pa., 1968. p.28-32.

Three basic factors which can affect the amount of solid refuse generated in an area or community are: geography, economics, and industrial and manufacturing activity. The current amount of solid waste generated per capita per year in Manatee County and Sarasota County is 1,240 lb and 1,220 lb per capita per year, respectively. The overall national average of refuse produced per capita is 1,620 lb per capita per year. The economic and industrial activity factors reduce the average quantities generated in the two counties, while the geographical factor is the only one tending to increase the average. Practically all of the refuse produced in each county originates in households, commercial business establishments, restaurants, or institutions. Tropicana is the one industry producing a significant amount of solid waste in Manatee County. Currently, this plant disposes of 240 tons of solid waste per month in public landfills. To determine the future solid waste disposal requirements for Manatee and Sarasota Counties, it is necessary to forecast the population changes and the per capita refuse production changes. Using a 2 percent increase and 1,230 lb per year per capita for 1967, projections were made of refuse quantities to the year 1980 for Manatee and Sarasota Counties.

68-0194

Day and Zimmerman, Inc. Proposed solid waste disposal facilities. In Solid waste disposal report for counties of Manatee and Sarasota, Florida. Philadelphia, Pa., 1968. p.33-68.

The solid waste disposal facilities which were proposed are: county operated sanitary landfill, incineration, composting, truck transfer station, private solid waste disposal facility, disposal of bulky metal items, and shredder installation for oversized waste. Based on current costs and projected quantities of solid waste, sanitary landfilling should be continued in both counties through 1980. It is estimated that the costs of sanitary landfilling will be \$1.85 per ton in each county. Each county should establish an independent department within the county government which will have complete responsibility for all solid waste disposal within the county. In 1980, the counties should evaluate the desirability of incineration and composting versus sanitary landfilling. At that time, it may be necessary to construct truck transfer stations since likely sanitary landfill sites may be located in the eastern portions of the county and out of range for economical compactor truck operation. With the added cost of a transfer station, it may be desirable to have a combination of incineration or composting and sanitary

landfilling, or truck transfer stations and sanitary landfilling. All these alternatives should be reviewed in 1980.

68-0195

Deep well disposal of problem wastes. Factory, 126(4):148-150, Apr. 1968.

A growing number of industries are using deep well injection to dispose of wastes which are either too difficult or too expensive to handle by more conventional techniques. Efforts to recover useful byproducts or regenerate acids from steel mill pickle liquors have not been very successful. A typical deep-well installation is described which goes down to 6,000 ft below the surface into a layer of sandstone and can handle 100,000 gal per day of highly concentrated wastes. In one plant, it was estimated that it would cost \$32,900 per month to neutralize acids compared to \$5,100 for deep well disposal. Where recovery of calcium chloride and potassium chloride salts from brine wastes is not economical, brine has been injected at 320 to 359 gal per minute under 400 to 450 psi into dolomite and limestone layers 4,000 ft below ground water sources. Surge ponds handle excess flow. Excess sludge from activated sludge plants has been thickened and then fed at 60 gal per minute into two wells at 600 to 2,000 psi. After 4 years, the deep well sludge disposal has cost only three-quarters of the equipment costs of incineration and half the operating costs.

68-0196

Deep well injection is effective for waste disposal. Environmental Science and Technology, 2(6):406-410, June 1968.

In the past 4 years, the number of waste injection wells drilled in the U.S. has more than doubled to about 110. More than half of these were drilled by chemical, petrochemical, or pharmaceutical companies for the disposal of organic and inorganic wastes. At present, injection systems are heavily concentrated in the north-central and Gulf Coast states where favorable geology, industrial concentration, and existing legislation favor subsurface disposal systems. The technology of injection (based on brine injection) is already highly developed. At an acrylonitrile-producing plant, the waste stream was incinerated at an operating cost of \$600,000 per year. Initial costs of a deep-well system will run about \$270,000, and its annual operation about \$100,000. In this case the porous sandstone layer, 3,000 ft below the surface, offers efficient lateral dispersion. The majority of wells are less than 6,000 ft deep and some systems have been built for under \$50,000. Most State regulations governing drilling and deep-well disposal systems are aimed primarily at the protection of ground water supplies and mineral deposits. Additional research is required with regard to specific geological structures.

68-0197

Eight year growth began with 400 customers. Solid Wastes Management/Refuse Removal Journal, 11(10):36-37, Oct. 1968.

Some of the unusual problems encountered by one disposal contractor in Florida are described. Smoldering and burning

coffee beans, and coffee bean dust are unusual wastes and drivers collecting them are equipped with fire extinguishers to prevent their trucks from catching fire. Since there are strictly enforced regulations against dumping refuse in Florida's coastal waters, the company provides specially designed container services to ships when they drop anchor at Jacksonville. The company's landfill site is so low that as soon as a hole is dug for the purpose of burying refuse, the cavity fills to overflowing and must be pumped out at least once during the dumping operation.

68-0198

Elliot, A. M. Subsurface waste disposal problems. *Water and Sewage Works*, 115(1968) R 203 R 209, Nov. 29, 1968.

Problems encountered in subsurface waste injection are illustrated by tracing the history of an actual well. The problems encountered when the aquifers selected do not receive the waste as indicated, by decreased flows and increased well head pressures, are specifically considered. The well was to accept an aqueous waste stream containing less than 5 percent organic and inorganic acids into sand formations containing natural brine. Permeability of the aquifers was considered good, as was compatibility of the waste with liquids taken from the actual injection zones. Each step in the drilling operation and perforation of the well is described. Continuing operational problems involving sanding up of the well were experienced. The various types of highly specialized equipment for operating within wells are generally supplied from a specific vendor who has the experience to deal with specific elements of a problem. It was finally decided to seal the well at a point which left only one of the original four disposal aquifers operational. The solutions to problems arising with subsurface disposal operations involve correlating all available indicators, consultations with knowledgeable people, making a decision, and trying it.

68-0199

Environmental engineering stars at ASCE Chattanooga meeting. *Civil Engineering*, 38(6):44-51, June 1968.

The American Society of Civil Engineers National Meeting on Environmental Engineering, held in May 1968, is reported. Several solid waste disposal topics were discussed. In cases where TVA power plants obtain their coal from strip mines, TVA now requires reclamation of spent mines. The Water and Waste-Water Technical School at Neosho, Missouri has trained more than 2,000 people since 1960. A second school is to soon be opened in Middletown, Pennsylvania. Cornell University representatives reported on problems in handling animal wastes. A hill was constructed using municipal refuse in the city of Virginia Beach. Its sides will form an amphitheater for theater events and a soap box derby hill, while the top will be used for parking.

68-0200

Ertola, J. A. Garbage power. *San Francisco Business*, 3(48):52-58, Aug. 1, 1968.

The president of San Francisco's Board of Supervisors recounts experiences of a group of civic and business leaders

on a recent tour of refuse incineration plants in Europe. The ultramodern refuse incineration plant in Munich is also a power station. In Houston, there was a composting plant capable of utilizing some 300 tons of garbage each day, but what little was composted resulted in more compost than the market could absorb. The compost was piled into high hills behind the plant exposed to the sun. Another compost plant, in Florida, was hailed in 1 year as a tremendous achievement, but was shut down the next year, proving a public nuisance. In Georgia, an open dump with open burning that produced clouds of black smoke was viewed. In Germany, a practical, economical, pollution-free, odor-free answer to San Francisco's recurring crisis in refuse disposal was found. In West Berlin, a modern structure housing a steam-production and cinder block-making plant is fueled by the refuse of 1.1 million West Berliners, some 2,000 tons each day. Reclamation of power for heat and light and production of bricks to be used in reconstructing the city indicates the completeness of refuse utilization. Duesseldorf, a modern city experiencing a great regeneration from the destruction of the war, also has a refuse plant for the production of electrical power.

68-0201

Experts see spy-proof "waste basket". *Waste Trade Journal*, 64(38) 8, Sept. 28, 1968.

Spy-proof discard of industrial and business documents is guaranteed by a high-capacity "wet wastebasket". The Wascon machine consists of a steel tank, nearly filled with water, with steel blades around a rim near the bottom, and a steel disk imbedded with jagged carbide teeth. All material is destroyed by pulverization while the water dissolves the ink. A water press squeezes about 95 percent of the water out, and the resulting semidry pulp is discharged into a disposal receptacle.

68-0202

Falls, E. D., Jr. Your community is it a giant litterbug? *American Home*, 17(2):16, 18, 19, Mar. 1968.

Today's incredible volume of packaging increases the serious dump problems of nearly every American community. In a few years, the average family will toss out 60 pounds of waste daily. Numerous existing methods of disposal are highly unsatisfactory. Until recently, San Francisco garbage had been dumped into its bay at Brisbane, California. In Boston, the Atlantic Ocean has been considered for refuse disposal. Westchester, New York, proposed hauling its trash away by a midnight train, and dumping it at some distant location. Not only have the lands and waters become polluted, but the sky also. Ordinary burning cuts waste volume in half, but adds smoke, fumes, and dust to the air. More satisfactory solutions might be extra-hot incineration, sanitary landfills in dry areas, composting and salvage, and pounding and grinding to convert refuse into a new kind of soil. New ideas for refuse collection include disposable trash bags and waste pipes which would flush away household garbage. Though each of these methods has its drawbacks—predominantly in cost—they all may contribute to solving the tremendous solid waste problem in America.

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68-0203

Floyd, E. P., and N. S. Ulmer. Methods for the physical and chemical characterization of solid wastes. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. H-6.)

A project was initiated under the Solid Wastes Program, U.S. Public Health Service, to determine, recommend, and publish analytical methods which can be employed to measure satisfactorily the physical and chemical parameters of solid wastes. Research efforts have been concentrated on procedures for the determination of five chemical constituents of solid wastes. Oven-drying, freeze-drying, and extraction-drying procedures have been compared, and a modified combustion furnace and absorption train are now being evaluated to determine their applicability in the gravimetric determination of carbon and hydrogen in refuse. The Coleman Nitrogen Analyzer technique and several digestion-distillation procedures are being investigated in relation to determination of total nitrogen. Various modifications of the biochemical oxygen demand (BOD) method are being employed in determining the BOD of incinerator quench water.

68-0204

Floyd, E. P., and N. S. Ulmer. The sampling and preparation of solid wastes for analysis. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. H-5.)

A research project was initiated by the Solid Wastes Program, U.S. Public Health Service, to define the variables affecting the character of both the total solid wastes and the sample selected for analysis. Another objective was to develop, evaluate, and establish techniques, instruments, and equipment for the selection, collection, handling, preservation, storage, shipment, and preparation of samples of all types of refuse before, during, and after processing. Processing may be by incineration, sanitary landfill, or composting. To facilitate the removal of water from refuse, compost, and incinerator residue prior to particle size reduction or additional analyses, oven-drying, freeze-drying, and extraction-drying procedures have been investigated. A Sears Compost Grinder, a Wiley Mill, a W-W Hammermill, and a meat grinder have been employed to grind various solid waste samples, while mixers and homogenizers have been utilized in an effort to increase sample homogeneity.

68-0205

For solid wastes: squeeze and package. *Chemical Week*, 102(14):55, Apr. 6, 1968.

It is reported that if a 3000-ton Japanese refuse processing press is utilized, there is no need to sort waste, there is no need to incinerate, waste is compacted into sealed blocks, and the aerobic and anaerobic bacteria sealed into the blocks are eventually killed, thus eliminating a health hazard. The process involves three basic steps: compression, asphaltting, and packing. The blocks can be used for ocean dumping, landfill, and for such construction as building foundations, shore protection, and flood prevention works.

68-0206

Freed, V. H., R. R. Groner, and J. F. Barbour. Chemical transformation of solid waste. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. H-4.)

Chemical transformation is being evaluated as a potentially useful means of treating solid wastes in order to reduce bulk, produce useful products, and reduce air and water pollution. The general composition of straw, bark dust, and composted municipal refuse is reported in tabular form. The utilization of the components found in these solid wastes (cellulose, metals, glass, lignins, and animal and vegetable matter) may require separation by solvent extraction, hydrolysis, distillation, or degradation. A list of potential applications for extracted cellulose is presented. Straw, paper, and other wastes have been subjected to treatment with urea, phosphoric acid, and potassium salts to raise the concentrations of nitrogen, phosphorus, and potassium. Straw, paper, and bark dust have been subjected to high-pressure hydrogenation to obtain a hydrocarbon oil. Cellulose has been extracted from straw, bark dust, and compost through the formation of cellulose xanthate.

68-0207

Freestone, A. Environmental sanitation on Indian reserves. *Canadian Journal of Public Health*, 59(1):25-27, Jan. 1968.

The environmental problems of 83 reserves with 31,000 people in Saskatchewan, Canada, are described. The sanitation program of the Department of Indian and Northern Health Services, Canada, included health education workshops. Water systems have been completed or are under construction. Garbage disposal clean-up campaigns were organized and promoted. A few waste disposal grounds have been established, usually of a landfill type. Only one village has organized garbage pickup.

68-0208

Garbage: rosy new future as raw material. *Chemical Engineering*, 75(9):82-84, Apr. 23, 1968.

Current solid waste disposal technology is reviewed and the steadily increasing tonnage of disposable solid waste in the United States is stressed. The per capita discharge of solid wastes has grown in the past 35 years (1930-1965) from 2.2 to 4.5 lb per day, with 30 million tons of paper, 4 million tons of plastic, 48 billion cans, and 26 billion bottles thrown away in a typical year. Several new attempts at a solution of the disposal problem are enumerated. They include: the concept of compressing garbage into building blocks developed in Japan, the conversion of wastes into a fibrous mass extrusion into combustible fuel blocks (planned by the Eriez Mfg. Co.), and the construction of a ski slope from compacted garbage near Chicago. Improvements in conventional ways of solid waste disposal are also mentioned. Open burning is now prohibited in landfill operations; instead, wastes to be disposed are covered daily with a layer of clean earth. Attempts to reduce the costs of waste transportation, estimated at 75 percent of the total handling expenses, are being undertaken by the American Public Works Association in Chicago and the University of

Pennsylvania. The university is studying the feasibility of running a liquid slurry of solid waste through a pipeline. Other problems under study are the disposal of junked cars and packaging materials.

68-0209

Garbage situation alarming, say experts. *Clean Air News*, 2(6): 7-10, Feb. 27, 1968.

New York City produces 7 million tons per year of refuse and the average American is responsible for 4.5 lb per day of trash. Solutions offered include: compressing garbage into bricks used for landfill or building material, composting refuse into fertile humus for crops, and transporting trash to abandoned mining cavities. Disposable items which are not destructible, and incinerators which spew tons of soot into the air are serious problems. Sanitary landfill has consumed nearly all the accessible open acreage around major cities—New York City's landfill program uses up 200 acres of swampy lowland per year. According to some planners, crushing of wastes with a compacting device, and then rail hauling to rural areas would have many benefits. The ultimate solution for garbage would be its conversion into something useful.

68-0210

Godin, P., and J. Belko. A new approach to cage waste disposal in a canine laboratory. *Laboratory Animal Care*, 18(3): 401-404, June 1968.

A dog cage is described which has been in use 3 years, housing 25 animals in a small area, yet meeting all the requirements for good animal care. The cages are custom-installed prefabricated fiber glass, featuring a central drain that ties into existing public sewer lines. The cage drains through a 2-in. plastic pipe into a 3-in. soil line, which drops into an indirect waste system to a 4-in. soil trap. An automatic flush system connected to the drain lines reduces both odors and labor. This is controlled by a day-night timing device. The labor involved in cage cleaning has been decreased by half. The general condition of the dogs has improved, and the number of parasites has diminished. Moisture resulting from evaporation has been minimal. Some of the advantages of a center drain cage design are: the depth of each battery is less than 3 ft, permitting a greater number of cages in the installation; waste is easily washed into the cage drain without moving the dog if further cleaning is necessary; and the plumbing fixtures are easily serviced through the front panels.

68-0211

Gofueke, C. G., and S. A. Klein. Treating combined liquid and solid wastes. Presented at 1968 Conference of California Water Pollution Control Association, Santa Rosa, Apr. 24-25, 1968. 15 p.

The traditional distinction between solid and liquid wastes in the classification of material and the method of treatment is increasingly difficult to maintain. Some factors contributing to this loss of distinction are: trends toward regional jurisdiction, industrialization of production of animals for slaughter and animal products, change from automotive to pipe transport, and the processing of wastes to reclaim resource materials. Four methods, anaerobic digestion, wet

oxidation, biological fractionation, and photosynthetic reclamation, can be used in treating aqueous suspensions of the organic fraction of wastes. Research and practical experience demonstrate that the addition of the garbage fraction of solid wastes imposes no need to alter present anaerobic digestion practices. Research on the use of wet oxidation, biological fractionation, and photosynthetic reclamation in treating aqueous suspensions of solid wastes is in preliminary stages. However, these systems can probably be successfully applied to solid wastes to produce useful materials as part of the treatment process.

68-0212

Hamburg, F. C. Economically feasible alternatives to open burning in railroad freight car dismantling. Paper 68-179. Presented at Annual Meeting, Air Pollution Control Association, St. Paul, Minn., June 24-27, 1968. 25 p.

A study was performed under contract with the Solid Wastes Program, Public Health Program to determine methods of railroad car dismantling in which pollutant emissions could be reduced to acceptable levels or eliminated entirely. Eight criteria and eleven candidate methods were evaluated by application of a forced decision model. The two highest scoring methods were: emission-controlled wood incineration within the confines of each car by means of a special stack or hood configuration; and the use of high-pressure water jets to cut away the wood. The water jet method holds promise of wide applicability to the cutting, penetration, fragmentation, and disposal of solid material. These methods have been demonstrated in principle by actual field tests performed on box cars in scrap yards.

68-0213

Hoffman, D. A., and R. A. Fitz. Pyrolysis of solid municipal waste. In *Engineering Foundation Research Conference: Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. C-1.)

The feasibility of pyrolysis as an economic method of decreasing the volume of solid municipal waste was investigated. First the composition of 'typical refuse' from San Diego's three sanitary landfills was determined. It was found that about 50 percent of the material was construction debris and fill dirt. The average composition of the balance of the waste is tabulated. Pyrolysis investigations were made using the 'typical refuse' samples (without glass and metal) at four temperatures. The products of the pyrolysis were gases, pyrolytic acids, and residual char. The evolved gases were carbon dioxide, carbon monoxide, methane, hydrogen, ethane, and ethylene. Data indicate that a pyrolysis operation using the combustible portion of San Diego solid waste will, once raised to the chosen operating temperature, sustain itself by the energy derived from the incineration of its own products.

68-0214

Ilehart, C. C. Municipal trial-and-error decisions called appalling. *Solid Wastes Management/Refuse Removal Journal*, 11(10):48, 64, Oct. 1968.

Lack of public interest in solid wastes disposal has resulted in trial and error methods being applied to disposal problems,

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with resulting waste of money. Rural Kentucky dumps refuse along the roadside, but the small political subdivisions lack the resources to support acceptable disposal operations. The Kentucky State Department of Health has attempted to cope with the above problems by establishing a full-time planning agency within the Division of Environmental Health for all solid waste activities. After June 13, 1968, permits will be required for the construction, operation, or maintenance of a new solid waste disposal site or facility or for the transfer of an old one. It will now also be possible to form refuse disposal districts through action by the courts.

68-0215

Ingram, W. T., and F. P. Francia. Investigation of existing disposal facilities. In *Quad-city solid wastes project, an interim report June 1, 1966 to May 31, 1967*. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. p.6(1-10).

Private landfills presently in use for disposal of solid wastes collected in the Quad-city area were investigated as to operation and cost. All are located in the New Jersey meadowlands with the exception of one which is located in an area known as the Great Piece Meadows-Hatfield Swamp. Gas and smoke, differential settlement, underground and aboveground fires, poor access road maintenance, and dust generation were among problems noticed. Cost varied from approximately \$1.50 to \$4.00 per ton. Increasing social and government pressure upon these operations makes incineration more attractive. Six plants were examined and visited and extensive technical, construction, and operating costs data were obtained. Construction costs varied from \$2,600 to \$10,000 per ton per day. A suitable plant for Quad-city is estimated to cost about \$8,000 per ton per day, exclusive of land and elaborate air cleaning facilities. Composting, including the Dano system, the Rasping system, the Van Maanen System, and the Hammermill System, was examined through interviews with five companies. Costs for a 300-ton per day plant were estimated at \$5 to \$6 per ton of processed material. Grinding, salvaging, compaction, shredding, and combination shredders, and composting were considered to be only partial solutions. High-temperature combustion, using the Melt-Zit system, was estimated to save an operating cost of \$3.30 to \$3.40 per ton of processed material. Rail haul and sanitary landfill to areas distant from the producing area have a tentative operating cost of \$4 to \$5 per ton from transfer station to final disposal.

68-0216

The Institution's evidence to the Working Party on Refuse Disposal. *Journal of the Institution of Municipal Engineers*, 95(3):77-78, Mar. 1968.

The statements of the Institution on the subject of refuse disposal are reprinted. Disposal plans must be drawn with the knowledge of town and country planning requirements, and the possible link-up with sewage disposal must be given serious consideration. Land reclamation and other engineering works must be carried out on sound principles. Refuse disposal must be organized; joint or regional schemes are to be encouraged. On-site reduction of refuse should be encouraged, i.e., home incinerators, and garbage disposals. Reduction in bulk of refuse, through maceration and compression, should be encouraged. Incineration may result

in expensive hauling of refuse, but should be considered because it both reduces the bulk and improves the qualities of refuse and can further provide municipal power. Tipping should be continued, where possible, keeping in mind the possibilities of land reclamation. Materials lending themselves to reclamation and salvage should be salvaged where possible, and the economics of fertilizer production from refuse should be considered. Some degree of standardization of refuse plants might prove useful from the point of view of parts and training of operators. Research and information in the field will be of the greatest value to the authorities. Liaison with community services and industrial concerns must be encouraged and expanded.

68-0217

International work group for waste research. *Gas und Wasserfach. Wasser, Abwasser*, 109(10): 261, Mar. 1968.

The international work group for waste research (IAM), Zurich, Switzerland, issued a leaflet, No. 31, in December 1967. The leaflet contains articles on: "The Blood-Forming Effect of Composted Waste on Young Pigs," by V. Teensma; "Method for the Planning and Preparatory Work in the Construction of Plants to Utilize Household Wastes," by G. Sundhoff; "What is the Capacity of a Waste Incinerator Plant?" by W. Wilmann; and "Accumulation and Elimination of Only Waste," by R. Bopp. The leaflet was issued by the secretariat of the IAM, Dr. Rudolf Braun, Eng. Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewässerschutz, CH-8044 Zurich, Physikstrasse 5. (Text in German).

68-0218

Kennedy, J. C. Current concepts in the disposal of solid wastes. *Journal of Environmental Health*, 31(2):149-153, Sept.-Oct., 1968.

Reduction or degrading wastes into forms which are least offensive to the environment is accomplished by mechanical processes such as sanitary landfill, thermal reduction such as pyrolysis; biological reduction such as composting; and chemical reduction. Synthesis of waste material involves an operation which makes the waste of value to the economic community; mechanical, thermal, biological, and chemical methods are used to accomplish this. In reduction processes, the aspect of quantity is dominant, to satisfy both spatial and public health requirements, whereas in synthesis techniques, the qualitative aspects are more important as both market factors and public health requirements must be considered. The chosen techniques are evaluated through consideration of various operational indices. The basic indices are weight, volume, time, and cost. These indices are discussed briefly and their use in obtaining insights into operation of a system, and in comparing systems, is stressed. Much research is needed to further identify and establish these operational indices so that a more positive relationship with the natural environment may be obtained.

68-0219

Keune, H. Pollution of the sea. *Chemie-Ingenieur-Technik*, 40(6):A263-A267, Mar. 1968.

In the fall of 1967, two international symposia were held at which the pollution of the sea by waste water, sludge, and

solid wastes from municipalities and industries was discussed. The first symposium was held between September 19 and 22, 1967 in Helgoland. The papers dealt with the main sources of the pollution, with processes which modify the distribution and composition of the pollutants, with the consequences of the pollution, and with local aspects. From what was said it became clear that there is no research going on to discover the effects of the waste material on marine life. At present all kinds of waste go into the North Sea, e.g. domestic and industrial wastes, hot waste water, oil, radioactive wastes, etc. Waste material in containers may only be dumped into the deep sea. Solid wastes dumped into coastal waters must be soluble, or if they are insoluble, they must be fine ground and must have a specific weight of more than 1.2. In addition, they must not impair biological processes. Sludge is dumped in great amounts into the North Sea. It is shipped from Germany and Great Britain in special boats. At the end of the symposium it was asked that the Northwest European Sea Board issue a list of waste materials which are most dangerous to marine life, and prohibit their dumping into the sea. The second international symposium dealt mainly with protecting the seacoasts from pollution, and it was held in Hamburg. The effects of waste on the sea cannot be exactly determined. No criteria for tolerance limits can be given. It is possible that bacteria contained in domestic waste can be ingested by sea fauna and, through them as intermediate hosts, become a source of infection for the population. Organic substances in the waste also destroy fauna in lagoons and river outlets. (Text in German)

68-0220

Mackintosh, G. R. Efficient disposal of kitchen waste. *New Zealand Journal of Agriculture*, 117(1):56-59, July 1968.

After the Waikato Hospital Board studied its garbage disposal system, it was decided that mechanical grinding and sewerage disposal could have disadvantages which outweighed their advantages. Several costly machines and additional plumbing would be required in addition to expensive maintenance. Of most concern, however, was the waste of good pig feed. The collection room facilities at the hospital are described. Each of the hospital's three kitchens has a garbage collection room where converted 20-gal milk cans with attached lids are placed on mobile, three-wheeled trolleys and wheeled, when full. Each evening the full cans are removed and a clean can is placed on each trolley by the contractor. The advantages of this hygienic, labor-saving, and noiseless system are: no labor or transport expenses in conveying food wastes to central collection points, no need for labor, or large quantities of boiling water and facilities formerly required to clean empty containers, no purchase of containers or frequent repair expenses, and no smells, or flies. Food waste is not stored in kitchens overnight, and stands for pig food are eliminated as is spillage resulting from tipping of waste from small drums to large containers. From the contractor's point of view, the food waste is received in better condition and a greater proportion of the waste is made available for good pig food.

68-0221

Mechanization is key to low-cost tree removal. *Public Works*, 99(1):104-105, Jan. 1968.

A two-man tree removal operation, which utilizes a truck-mounted, 5-ton telescoping crane, chain saws, a 12-in.

brush chipper, and a chip truck is described. An 85-ft tree can be removed in 2 hr, including chipping the branches on limbs too big to be run through the chipper, and raking the area. Use of the crane, a Pitman Hydra-Lift, allows removal of large sections of trees in one cut. The Pitman Wood/Chuck brush chipper reduces branches to one-fifteenth of their original volume and deposits them in a tarpaulin-covered chip truck. It is estimated that the chipper minimizes haulage costs. In the future, the chips may be sold instead of dumped.

68-0222

Merz, R. C., and R. Stone. Quantitative study of gas produced by decomposing refuse. *Public Works*, 99(11):86-87, Nov. 1968.

The gas produced by a fixed amount of refuse was measured by use of a 10,000-gal underground, sealed, refuse-containing, storage truck constructed of 1/4-in. A-36 steel, and equipped with thermistors and with perforated piping at top, bottom, and mid-depth to measure the evolved gasses. Temperature trends over a period of 750 days and gas production of the decomposing refuse are shown. Gas production for the first month was 39.3 cu ft. However, by the end of the second month, all gas production ceased. Temperatures within the tank were also found to be decreasing. On the 62nd day, 450 gal of water were added. The water did not result in an increase of gas production or a temperature rise, and a vacuum was produced. The 230th day saw a resumption of gas production and by the 250th day gas production amounted to 42 cu ft. In the ensuing 300 days, there was a uniform rate of gas production resulting in a total of 2,025 cu ft. Although the internal temperature did decrease over a 100-day period, the temperature range of 120 to 105 F was favorable for bacterial activity, as represented by the constant rate of gas production.

68-0223

Metcalf & Eddy, Engineers-Planners. Recommended refuse disposal plan. Norwich, Southeastern Connecticut Regional Planning Agency, Feb. 1968. 114 p.

Refuse disposal practices in the Southeastern Connecticut Region were studied, and recommendations were made for a refuse disposal plan. Private, contract, and municipal facilities were surveyed. Present methods of municipal disposal include dumping, sanitary landfill, and in one case, incineration. In addition to domestic refuse quantities, industrial and commercial waste, junk automobiles, sewage sludge, and fly ash quantities were determined and projections were made of future waste generation. Average annual costs for operating refuse systems were compared. Standards for refuse disposal were recommended. Facilities were categorized as to whether they should be abandoned, improved, or continued to 1990 in their present condition. Four alternative plans for refuse disposal were identified. The adoption of a subregional plan which involves central incineration and a subregional sanitary landfill was recommended. The Connecticut Public Health Code Requirements Concerning Disposal of Refuse and basic cost data used in the analysis of alternative plans are appended.

Disposal

68-0224

Metcalf & Eddy, Engineers-Planners. Existing refuse situation; definitions and available refuse disposal methods. In Recommended refuse disposal plan. Norwich, Southeastern Connecticut Regional Planning Agency, Feb. 1968. p.9-17.

Several terms, whose meanings are a prerequisite to understanding the refuse disposal plan, are defined. Scientific and technical advances have resulted in only three available and satisfactory methods for general refuse disposal. These methods are sanitary landfill, composting, and incineration. An important consideration is that cover material is not available on-site at many otherwise suitable landfill locations. Dumping space required for sanitary landfill is several times that needed for the disposal of incinerator residue and noncombustibles. If not sold, composting residue must be given away or disposed of as landfill. The final product amounts to about 50 percent of the raw refuse by volume. Disposal of refuse by composting is not recommended for southeastern Connecticut. The major disadvantage of incineration is cost. Assuming the disposal of bulky wastes directly at the landfill site without prior incineration, any given disposal area would last three to four times as long with the incineration disposal method as it would with sanitary landfill. Special disposal methods discussed included garbage grinding, on-site incineration, hog feeding, shredding, salvage, and dumping at sea.

68-0225

Metcalf & Eddy, Engineers-Planners. Existing refuse situation; status of refuse planning, an inventory of present refuse collection and disposal practices. In Recommended refuse disposal plan. Norwich, Southeastern Connecticut Regional Planning Agency, Feb. 1968. p.18-46.

The 17 municipalities in the southeastern Connecticut region have been typically inactive in refuse planning, especially long-range planning. Only New London, North Stonington, and Groton have determined long-range disposal needs and have developed the plans to take care of the problem on a town basis. Refuse disposal facilities were grouped according to the basis for their service into three classifications: municipal facilities, contract facilities, and private facilities. The municipal refuse disposal facilities in the region are described in terms of their type, ownership, service area, site characteristics, land use, zoning, quantity of refuse, and kinds of refuse handled. Four contract disposal facilities are described and their locations are indicated. The most recent operating cost data for the various towns and collection districts in southeastern Connecticut are listed. The factors which have significantly affected operating costs for refuse disposal are the following: type of disposal facility, source of cover material, facility operation and control, and types refuse accepted. Special waste problems were classified as follows: industrial and institutional hazardous and nonhazardous, junk vehicles, sewage solids, and special wastes such as fly ash.

68-0226

Metcalf & Eddy, Engineers-Planners. Existing refuse situation. Estimated future refuse disposal requirements. In Recommended refuse disposal plan. Norwich, Southeastern Connecticut Regional Planning Agency, Feb. 1968. p.47-54.

The estimates of future quantities to be handled by municipal facilities are projections of the quantities based on population projections for the service areas, future commercial and industrial growth, and the estimated effect of contractor and private disposal facilities. The year-round and seasonal populations by towns for 1966 were estimated and then projected for the years 1980 to 1990. Based on the regional development plan for southeastern Connecticut, a major regional industrial area is proposed for the industrial triangle around Waterford, Norwich, New London, and Groton have been identified as subregional commercial centers to serve the regional population in the year 2000. Increases ranging from 1.1 to 1.6 times the present per capita refuse quantities are estimated for the years 1980 to 1990. The current rate of junk car production is one car per year for every 25.7 people. By 1980 and 1990, there will be one car for every 18 and 16 persons, respectively. By 1990, the projected rate of production of sewage solids is estimated at 0.30 lb per capita per day.

68-0227

Metcalf & Eddy, Engineers-Planners. Existing refuse situation. Adequacy of existing disposal methods and locations for present and future use. In Recommended refuse disposal plan. Norwich, Southeastern Connecticut Regional Planning Agency, Feb. 1968. p.54-70.

Recommended standards for general refuse disposal methods in southeastern Connecticut are presented. Municipal facilities are presently used to dispose of approximately 86 percent of all refuse produced in the area. With the exception of the New London incinerator, the method of disposal for all municipally disposed refuse is some form of dumping—either sanitary landfill, modified sanitary landfill, or open dumping. Each facility was evaluated according to the relationship between the cumulative volume of material covered and the available space, its location with respect to existing land use, and whether the present method of disposal is acceptable. The facilities were grouped under the following categories: sites recommended for abandonment by 1970, 1980, or 1990; sites suitable for continued use through 1990 with moderate corrections in disposal methods; and sites suitable for continued use through 1990. Based on design capacity and predicted future refuse quantities, the New London incinerator was judged capable of meeting needs through 1990. It was concluded that all the existing contract facilities can continue in use with proper corrective measures.

68-0228

Metcalf & Eddy, Engineers-Planners. Recommended refuse disposal plan. Alternative refuse disposal plans. In Recommended refuse disposal plan. Norwich, Southeastern Connecticut Regional Planning Agency, Feb. 1968. p.72-93.

In studying solutions for southeastern Connecticut regional refuse problems, four general factors have been considered: availability of suitable sites, including land use considerations; political implications; costs; and flexibility of solutions. Sites must be in an area designated for either industrial or very low density land use. A 50 percent safety factor in size is applied for long-range land area requirements. The preservation of water resources, natural resources, and natural features must be considered. Three possible

alternative plans were studied. They are designated as follows: Total Regional Plan, Subregional Plan, and Individual Municipal Plan. The first plan places the service of the entire region under the control of a single solid waste disposal authority. The Subregional Plan considers central incineration only or central incineration with subregional sanitary landfills. The Municipal Plan is based on the responsibility for disposal service remaining with each individual municipality. A cost comparison for the various alternative plans is presented. With respect to average annual costs the Subregional Plan with central incineration and sanitary landfills is the most favorable. The plans were also compared with respect to the available sites, transfer stations, timing, and the size of towns.

68-0229

Michaels, A. In 1978. Solid Wastes Management/ Refuse Removal Journal, 11(1): 79, 94, Jan. 1968.

Between 1939 and 1963, production of paper products rose from 13 million tons to 39 million tons, while the percentage of waste paper used in paper production has diminished from over 30 percent in 1939 to under 20 percent in 1967, thus greatly contributing to the problem of disposing solid wastes. The National Research Council of the National Academy of Sciences estimates that current daily refuse disposal amounts to 4.5 lb per capita, and will rise at the rate of 2 percent per year. This implies that the corresponding 1978 level will be approximately 5.7 lb per person per day. The composition of solid wastes has likewise changed. The percentages of food wastes and household ashes have decreased, while the percentages of glass and metal have risen. It would appear reasonable to assume that household ashes will continue to decline and may be insignificant as a component of refuse by 1978. Paper waste is expected to maintain its current relative position or even to increase it. Plastic wastes may increase. The shift in population from rural to urban areas is continuing, and 75 percent of the population will be urban by 1978. Thus the concentrations of refuse will increase, while the land available for refuse disposal in urban areas will decline. The manner in which the problem of wastes disposal will be handled in the future will depend on such factors as public concern, technology, and governmental actions.

68-0230

Muhich, A. J., A. J. Klee, and P. W. Britton. Preliminary data analysis: 1968 National survey of community solid waste practices. Public Health Service Publication No. 1867. Washington, U.S. Government Printing Office, 1968. 483 p.

Due to provisions of the Solid Waste Disposal Act of 1965, the Solid Wastes Program of the Public Health Service has undertaken a nationwide survey of solid waste disposal practices and problems. The survey is being conducted in conjunction with a State and interstate planning grant program. Data from thirty States and the District of Columbia received before July 1, 1968, are included in this publication. Information from three additional States partially surveyed by Solid Wastes Program personnel is also presented. The publication gives basic statistical summaries of the national survey data. It not only reports on community practices, but it assesses disposal sites and facilities as well. National analyses are presented for community data and land

disposal sites and facilities; regional analyses are given for the community data and the land disposal sites. In addition, an urban-rural comparison is provided for the community data. A separate analysis for incinerators is given. Attributive and continuous types of response are discussed. 'Sample size' and 'percent response' are given for both types. Attributive response applies when an answer can be placed in a limited number of categories, e.g., 'Yes' or 'No'; 'regulations enforced', 'no regulations', or 'regulations not enforced'. The continuous response, dealing with quantitative data, is treated somewhat differently. Such data applies when an answer is a count or measurement (number of animals, estimate in yards, etc.) and is summarized as 'total,' 'mean,' 'standard deviation,' '1967 population responding,' and 'mean per thousand.'

68-0231

New method of bagasse disposal at Mhlume factory. South African Sugar Journal, 52(7): 619, July 1968.

The Mhlume (Swaziland) Sugar Company's mill suffered from a large surplus of bagasse, the disposal of which finally became extremely expensive. After extensive studies, a Rees Burner was adapted to burn bagasse at a rate of some 8 to 10 tons per hr. Since the beginning of the present sugar crop, this burner has been in continuous operation and has successfully burned the entire surplus of bagasse. Operating costs are limited to the pay of two unskilled workers plus the cost of power required for two 25 hp fan motors. The bagasse is being burned completely and even after seven weeks of operation, it has not yet been necessary to remove any ash. There are also no smoke problems.

68-0232

Nonwovens are latest wave in the disposables sea. Modern Hospital, 111(4): 136, 138, Oct. 1968.

Disposable patient bedding and apparel have been adopted in both special and routine applications in many hospitals. Theda Clark Memorial Hospital in Neenah, Wisconsin, has a large modern incinerator only 60 ft from the laundry sorting room, where nonwoven fabrics are separated from conventional linens. Roosevelt Memorial Hospital in Chicago has an unsatisfactory incinerator which might be supplemented or replaced with a haul-away trash disposal process. General Hospital in Pontiac, Michigan, expects to use a grinder plus a haul-away system to dispose of nonwoven sheets, pillow cases, and gowns.

68-0233

Per capita waste generation near 35 pounds a day. Chemical & Engineering News, 46(4): 16, Jan 22, 1968.

Solid waste generation is now nearly 35 lb per capita per day, including 2.5 lb of domestic, commercial/industrial, and demolition wastes, 8 lb of vegetable wastes (mainly from agriculture and canning), and 19.5 lb of animal wastes. To handle these wastes, numerous techniques are applied, none of which is completely satisfactory. New ways to handle solid wastes are being sought, including various kinds of slurries and suspensions, composting, and possible conversion of paper to protein. Landfill is often a solution to dispose of

Disposal

solid wastes, and incineration gives the largest reduction in volume (50-70:1) but can lead to air and water pollution problems. The Louisiana delta country where the water table is near the surface presents a special problem, and the Louisiana Gulf Research Institute, affiliated with 26 universities in the State, and with the backing of civic organizations and major industries, is currently engaged in a Louisiana-wide environmental research program to solve pollution problems. The program includes developing a master plan which will be modified almost continuously.

68-0234

Pollution-control system destroys underground-storage waste products. *Gas Age*, 135(11):15-19, Nov. 1968.

The problem of how to dispose of liquid waste (70% water and 30% hydrocarbon-mercaptan) from underground gas withdrawal operations has been solved by the use of a high-temperature chemistry process in a pyro-decomposition system. Originally, the waste was collected and dumped into an open, dish-shaped excavation and set afire. The odor was offensive and the plumes of smoke could be seen for miles. The pyro-decomposition system consists of a heavily insulated, refractory-lined stack, a burner assembly, a blower, a pumping system, and suitable piping, valves, and controls. The fine dispersion of waste combustibles and high operating temperature (2,400 F) combine to make atomization and ignition almost simultaneous. Ionization takes place in the upper area of the stack ensuring controlled, pollution-free emission from the top of the stack.

68-0235

Proceedings: Third Annual Meeting, Institute for Solid Wastes, Miami Beach, Oct. 22-24, 1968. Chicago, American Public Works Association, 96 p.

The technical papers presented at the meeting covered such topics as: the system design approach to solid waste management; personnel accident prevention; development of public acceptance for site acquisition; the National Solid Wastes Survey; one-man operated collection vehicles; rail haul of solid wastes; and street sweeping as a means of controlling water pollution. Also included are: a report to the membership, a list of committees and their members, membership lists, and the by-laws of the Institute for Solid Wastes.

68-0236

Rasch, R. Common disposal of communal and industrial wastes. *Energie*, 20(4):112-114, Apr. 1968.

The disposal of communal and industrial wastes is one of the most pressing problems of today. At present, sanitary landfill is the most widely used disposal method because of its low costs. Another method, dumping wastes into the sea, has become highly controversial. The safest way to dispose of the waste is, doubtlessly, by incineration. It has been in use long enough so that valuable experience has been gained. For instance, crushing of waste prior to incineration is of great advantage, because it homogenizes the waste which

guarantees better combustion, so that no organic substances are left. Waste crushing becomes indispensable whenever communal and industrial wastes are burnt together, since the weight and heating value of industrial wastes differ greatly from those of domestic waste. The consistency also varies a great deal. For liquid and gas wastes, muffle furnaces and rotary tube furnaces are well suited. In the past years, frequent standstills have occurred due to corrosion. Fly coke and soot and components such as hydrogen chloride in the unburned gas attack the heat exchanger material. Homogenization of waste helps a great deal to reduce corrosion. A parallel flow combustion reduces susceptibility to corrosion because the waste material dries and ignites rapidly. The flue gases are usually cleaned in electrostatic precipitators, since the dust content in the cleaned gas may not exceed 150 mg per cu m at 7 percent carbon dioxide according to the new air pollution law. No cloth filters have been used yet with waste incinerators. To avoid dew point corrosion, the waste gases are cooled down to 200 or 300 C. The slag which remains from waste incineration is usually dumped, except in Berlin where the slag is treated for further use as construction material. (Text in German)

68-0237

Rees, D. F. Refuse disposal—way ahead for Britain. *Surveyor and Municipal Engineer*, 132(3977):33-34, Aug. 24, 1968.

The problems involved in refuse disposal in Great Britain are discussed from the viewpoint of the contractors and manufacturers who deal with refuse disposal equipment. The advantages and disadvantages of controlled tipping, incineration, and pulverization are listed. It is felt that an unrealistic attitude toward pulverization schemes is held by various authorities. A suggestion is made that the Working Party on Refuse Disposal issue an early Interim Report providing guidance in all aspects of waste disposal and utilization.

68-0238

Refuse analysis at Aberdeen. *Public Cleansing*, 58(2):70-71, Feb. 1968.

A three-deck riddle was constructed in Aberdeen for refuse analysis. The top deck utilizes 1 3/4-in. steel mesh, the second, 3/4-in. steel mesh and the bottom 5/16-in. steel mesh. Trays are fitted below this for collection of dust and fines. Material for analysis is selected on the basis of neighborhood so that a cross section of refuse might be obtained. It is weighed and analyzed. The results indicate differences in refuse composition as compared with the refuse of southern Scotland and England.

68-0239

Refuse disposal (NSCA Memorandum). *Smokeless Air*, 58(146):234-235, Summer 1968.

In dealing with refuse disposal systems and Clean Air agencies, the Society recommended that the scope of the public cleansing service should eliminate the need for the

disposal of refuse in small amounts; the disposal of refuse (including old motor cars) should only be permitted in plants or on licensed sites; and disposal plants should comply with a code designed to eliminate the emission of smoke, dust, and fumes. The Society is in accord with the Civic Amenities Act which enables a householder to dispose of his unwanted material through the regular refuse removal arrangements or at specially provided sites. A similar commercial arrangement would eliminate attempts to burn refuse, which conflicts with Clean Air principles. Where a large amount of refuse is to be disposed of, facilities should be provided for disposal on the site, either by incineration, tipping, or other methods. The Society advocates the registration of these disposal units by the local authority. There is a lack of recognized operation standards for disposal plants with regard to control of emissions. The Society advocates the acceleration of research and the development of a code which would achieve: incineration in properly designed incinerators, completely smokeless incinerators, the elimination of dust and grit, the prevention of dust and grit becoming airborne during handling, stricter control of tipping to eliminate fire risks, and the control of the disposal units to eliminate dust and grit.

68-0240

Refuse disposal in London. Surveyor and Municipal Engineer, 132(1992):55, Dec. 6, 1968.

In the 1967-68 report of the Refuse Disposal Branch of the Greater London Council Department of Public Health Engineering, it was estimated that the weight of London's refuse will increase by 70 percent over the next 20 yr. At present, the Council is dependent on land reclamation for the disposal of 90 percent of the refuse received. The scarcity of tipping sites, the high cost of pulverization treatment and transportation to distant sites, lead to a basic policy of incineration for the bulk of London's refuse. The council is also implementing a system for the disposal of old motor vehicles and bulky household items. The London boroughs are able to make use of a car-crushing plant which is operated by a contractor for the Council.

68-0241

Refuse disposal plants for Thailand. Engineer, 226(5879):472, Sept. 27, 1968.

Four refuse disposal plants to be installed in Thailand are designed to turn organic refuse into compost while inorganic rejects are incinerated. The three plants in Bangkok will be capable of receiving 320 tons per day of refuse and processing this amount continuously at the rate of 40 tons per hr; a Thonburi plant will have half this capacity. Refuse is pulverized, ferrous ingredients are extracted, and the refuse is passed to two separator systems. The compostable refuse is then conveyed to the fermentation house where temperatures rise to 70 C or more. The initial fermentation takes 5 days, after which the product is transferred to a storage area where it is left to cool and mature for 4 to 6 weeks. The compost is distributed as a soil conditioner. Rejects from both separators are transferred to the incinerator and clinker discharges are either transferred back to the compost or disposed of

separately by lorry.

68-0242

Report of the governor's task force on refuse disposal. Prepared by the Task Force with the Assistance of the Rhode Island Statewide Comprehensive Transportation and Land Use Planning Program. Providence, State of Rhode Island, Feb. 1968. 57 p. (Distributed by National Technical Information Service, Springfield, Va., as Publication No. PB 177 859.)

A general review of the refuse disposal problems in the State is presented, and a cooperative State and local program for the solution of these problems through 1990 is detailed. The majority of the communities in the State use inefficient and unhealthy disposal methods which are of particular concern in a highly urbanized state with a limited amount of vacant land. Sanitary landfill and incineration are recommended as the only feasible general disposal methods for the communities at this time. Composting, high temperature incineration, and other experimental methods are to be considered for the future. The estimate and forecast of refuse loads is based upon a current estimate of 5 lb per capita. Local governments should have the entire legal responsibility for the collection and disposal of all refuse generated within their borders. State government should develop and maintain an area-wide plan for refuse disposal, enforce regional arrangements, provide technical assistance, and set minimum standards. It is suggested that an annual State grant-in-aid fund of 40 cents per capita be apportioned to communities. Legislation to implement the proposals is presented.

68-0243

Robert A. Taft Sanitary Engineering Center. Summary report advanced waste treatment research program, July 1964-July 1967. Water Pollution Control Research Series, Advanced Waste Treatment Research WP-20-AWTR. Cincinnati, Federal Water Pollution Control Administration, 1968. 98 p.

Because of the need to prevent further pollution, only a limited number of solutions to the disposal problem are available. These include storage in sealed subsurface cavities or isolated surface ponds, disposal in the ocean, and conversion to innocuous or useful materials. A discussion of some of the processes of removal are: suspended solids removal; organic removal processes such as electrodialysis, reverse osmosis, and distillation; and advanced treatment methods. A summary of conveyance costs for rail, trucking, and pipeline are furnished in a table. Not all of the disposal methods are practical, and some do not completely fulfill the requirements of ultimate disposal. Complete disposal methods are incineration with conveyance of the ash to the sea, or direct conveyance of the waste to the sea. One point demonstrated by past studies is the high cost of conveying wastes long distances to the sea. Disposal methods such as conversion of waste to useful and innocuous forms deserve extensive investigation since they will reduce or eliminate the need for conveyance. In many sewage treatment plants today, sludge is incinerated and the ash is disposed of as landfill.

Disposal

68-0244

Robinson, W. D. Shredding municipal and industrial refuse for incineration. [New York]. American Society of Mechanical Engineers, Mar. 1968. 6 p.

Shredding of industrial and municipal refuse for disposal by incineration, landfill, or other methods will play an active role in disposal techniques of the future. For mass burning on grates the maximum particle size would not be as important as the bottom size. For partial suspension burning in furnaces at less than molten temperatures, the shredded topsize is most important and will likely be limited to 1 or 2 in. In maximum suspension burning, dry bottom furnace, control of size is most important with $\frac{1}{2}$ in. maximum topsize probably the requirement. A retort or cyclone type furnace at about 3,000 F with molten slagging walls, where the shredded material is blown into the furnace tangentially in a cyclonic pattern, requires a maximum tolerable topsize of about 4 in. The swing hammer type hammermill seems best suited to refuse service. Design criteria are given for the weight of the machine, rotor inertia, hammer weights and tip speed, shear and impact forces, rotor configuration, and feed and discharge devices. Electric motor, diesel, or steam turbine drives are available. Combined power and maintenance costs are estimated to be under \$1.00 per ton. A hood fabricated of steel plate and a screen are recommended for dust and shrapnel containment, and a dust collection system may be required. For refuse applications, noise levels will be less than with automobiles.

68-0245

Sarofim, A. F. Appendix C. Pyrolysis. In Summer study on the management of solid wastes; final report, v.1. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. p.34-37.

A brief description of pyrolysis is given, and its potential and problems are discussed. Pyrolysis involves destructive distillation in an inert atmosphere, usually carried out batchwise in an externally fired kiln. Two of the factors that detract from the use of pyrolysis for refuse disposal are the cost of reducing the refuse size to 3 in. or less, and the need for multiple small units in a plant of any appreciable size. The char produced from the pyrolysis of refuse is more than 50 percent metal, glass, and ash. The sale of the charcoal product requires prior separation from these inert materials, and it is expected that the reduction in size that would occur in the process would yield an inferior product. An investigation of the economics of the separation and the sale of the charcoal product is needed. It is doubtful that any significant credit can be obtained from the sale of the pyrolysis products. The operating cost would be expected to be higher than for an incinerator of the same capacity, due to high maintenance costs. Pyrolysis is seemingly not an economical method of disposing of refuse. However the use of pyrolysis for the disposal of demolition lumber may have potential, depending of the value of the charcoal produced.

68-0246

Schinzl, A. The behavior of substances difficult to decompose in the soil and in groundwater. Gas, Wasser, Waerme, 22(2):23-31, Feb. 1968.

After a brief description of the various layers of soil down to

the ground water level, the possibilities of foreign substances penetrating into ground water are discussed. There are two possibilities: substances may reach the ground water naturally, by the movement of liquid substances carried deep into the soil by gravity and taking solid substances with them; or they may penetrate artificially, from sump holes, from sand and gravel pits which have been stripped of the humus layer, from disposal sites for solid wastes (some types of waste attack humus which means that substances can penetrate the ground water layer without experiencing any decomposition), and from burial sites for animal carcasses, for leftovers from fish and meat canneries, and from human cemeteries. Substances which decompose slowly in the soil and which pollute ground water include chlorine, fluorine, and to some extent sulphate ions. Salt used to keep roads free of snow penetrated the ground water and contaminated the drinking water in an entire area in Massachusetts. Nitrate is also very difficult to decompose as shown by an incident involving leaking nitrate bombs. The drinking water of an entire area around the site (U.S.A.) was contaminated by the buried bombs. Fluorine contamination of ground water has been observed near a fertilizer plant in New Mexico. Cyanide was found in ground water near a disposal site for the aluminum plant in Ranshofen, Austria. Oil is another substance which decomposes in surface waters only in the presence of adequate oxygen, warm temperatures, and adequate plankton. Wastes from coking plants and oil refineries, such as tar and asphalt, are known to remain in the soil for many centuries. If they come into contact with water, large amounts are dissolved and carried into the ground water. Phenols spoil ground completely as do substances carried by the waste water from dry cleaning plants and the paper industry. Pesticides and detergents also pose a great danger to the ground water. (Text in German)

68-0247

Sebastian, F. P., and P. J. Cardinal. Solid waste disposal. Chemical Engineering, 75(22):112-117, Oct. 1968.

A multiple hearth incinerator disposes of sludge with 60 to 75 percent moisture and reduces it to one tenth of its original weight without additional fuel. The ash is sterile and inert. The discharge volume is about 10 percent of feed, and the discharge can be used in landfill or in bricks and concrete blocks. Tabulated are: ultimate disposal methods and costs; typical combustion values of waste materials; standard multiple hearth furnace sizes; and multiple hearth operating data and costs. Fluidized bed incinerators, which utilize a fluidized sand bed onto which mechanically dewatered sludge is fed, are described. The system operates under oxidizing conditions of 1,400 to 1,500 F. Wet air oxidation oxidizes sludge solids in liquid phase without mechanical dewatering by applying heat and pressure and using air to oxidize combustible matter. Such a plant in Chicago shows sludge processing costs at \$33.26 per ton of dry solids. This cost is divided almost equally between capital and operating costs. Low pressure oxidation is used to condition sludge for vacuum filtration and landfill. The Porteous steam injection process is a mechanical process which changes the physical structure of sludge. One advantage of the process is that it eliminates conditioning chemicals. Deep wells are not usually suitable for solid waste disposal because of plugging of the rock formations into which the stream is discharged. Sanitary landfill is frequently the cheapest method of disposing of sludge where there is a suitable site nearby.

68-0248

Sludge disposal at sea. *Civil Engineering*, 38 (8):62-63, Aug. 1968.

Philadelphia's sewage disposal plant on the banks of the Delaware River serves an area that discharges an average of 150 million gal of waste water every day, and processes daily about 200,000 lb of solids. The activated sludge treatment includes screening, grit removal, primary sedimentation, anaerobic sludge digestion, and final sludge disposal by seagoing barge. A series of five lagoons was being used as long as space permitted, but studies were undertaken to determine final sludge disposal. Incineration was rejected and a proposal for dredging the lagoons, with a portable, 10-in. hydraulic dredge, and loading a 2,700-ton barge with the residue was adopted. Before dredging begins, the thickened sludge is made less viscous by adding water. The resulting material averaged close to 10 percent solids by weight. The barge-filling operation takes about 8 hr, after which it is hauled 110 miles to the sea by a 1,600-hp tugboat. The sludge disposal area, about 10 miles out at sea, is located over a large hole in the floor of the sea. The discharge, through valves in the bottom of the barge, is manually controlled and the running time of the round trip is 30 hr. Cost is estimated at approximately \$4 per thousand gal, and some 100 million gal of liquid waste matter are handled in 150 trips per year.

68-0249

Smith, B. Incineration of ships' garbage in north is barrier against stock diseases from overseas. *New Zealand Journal of Agriculture*, 116(1):14-15, Jan. 1968.

Ship garbage, which can contain meat scraps, may introduce foot and mouth, and other diseases into New Zealand. The Animal Diseases Prevention Regulations, 1966, require every port or airport handling overseas vessels or aircraft to install incinerators to burn all the collected garbage. The incinerators used must be designed to cope with the high water content and the numerous bottles and cans found in the refuse. Excess liquid is drained off into evaporating trays within the incinerator. Bottles are incinerated and reduced to molten glass. Special containers were designed to avoid spilling liquid garbage. After the arrival of an overseas vessel, a number of these containers are put on by a Northland Harbour Board employee. When full, or on request, the garbage containers are collected by the garbage collecting boat and taken to Limestone Island. The empty drums and floors are steam-cleaned, and disinfectant foot baths are placed at the entrance to the incinerator room. Port agriculture officers maintain proper handling of garbage on board, and as a result, the risk of the introduction of disease through ships' garbage has been greatly reduced.

68-0250

Smooth flow and no bottlenecks. *Waste Trade World*, 112(5):11, 13, Feb. 3, 1968.

A plant in Glasgow is laid out to facilitate movement of material and to eliminate bottlenecks. The factory is surrounded by a 20-ft wide roadway which permits lorries to circulate freely, branching off to deliver waste into either end of the rectangular factory or to proceed to collect waste from the storage area. To prevent bottlenecks the designers

duplicate paper handling facilities at either end of the building. Conveyors are used extensively, from the delivery of the waste paper to the sorting and delivery of the paper to the baler. Conveyors are also used to deliver the paper to the sorting areas on the upper floor. The baler is a Shirlcliff Bulldozer baler with a ram rate of 10 strokes per minute, which is well suited to the mixed paper and shavings, low wrappers, and coated broke which the firm handles. It also has a feed hopper capable of dealing with unshredded paper at conveyor belt speed.

68-0251

Sorg, T. J., and R. L. Cummins. Commercial solid wastes studies. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. H-1.)

A 3-week study was conducted by the Solid Wastes Program, U.S. Public Health Service, on the solid waste produced by several types of commercial establishments in Cincinnati, Ohio. Four to eight various size stores were selected for each type of retail store—clothing, drug, grocery, hardware, and restaurant. The information collected was analyzed to determine any relationship between solid waste generation and size-related factors. A correlation coefficient was calculated for the solid waste generation weight and each size factor for each type of commercial store. Preliminary results of the study indicate correlations in clothing, drug, hardware stores, and restaurants between amount of solid waste per business day, and gross receipts. Other correlations were found between the amount of solid waste per business day and the area of store, average yearly inventory, equipment value, number of employees, and in the case of restaurants, number of customers served per day. In grocery stores, no correlation between solid waste generation and size factors was apparent.

68-0252

A study of solid wastes disposal and their effect on water quality in the San Francisco Bay-Delta Area. [Sacramento], California Department of Public Health, 1968. v.p.

This report is in reality a combination of two reports, covering solid wastes in general, and water quality in particular. On a population basis, the 13.8 million tons of solid waste generated during 1967 in the San Francisco Bay-Delta Area represented 13.4 lb per capita per day. There are 147 active sites in the Bay-Delta area for solid waste disposal, of which only 11 are classified as sanitary landfills. It was concluded that landfilling will continue to be the primary means of solid waste disposal within the study area for the next 10 to 15 years, and that during this period the small open dump will be eliminated and some of the bay tideland and marshland landfills will gradually be replaced by large inland canyon sites. In the future, there will probably be an increased interest in incineration and in grinders to dispose of solid waste to the sewerage systems. A greater emphasis should be placed on developing coordinated, long-range plans for solid waste management. Furthermore, policy and planning decisions for solid waste disposal, including future site locations, should be established on a regional basis. Considerable discussion is made of the water quality situation in the Bay-Delta area. Contact of adjacent

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water with solid wastes has long been a problem in maintaining water quality in the area. Conditions examined were discharge of decomposable solid to water, water passing through levees, drainage emerging from fills during ebbing tide, discolored water adjacent to fills, leachate emerging from fills, and serious odor production. Surface water pollution from solid waste disposal sites in the area is estimated to be small. Water quality recommendations are made for the area, based on the studies made and the categories covered. Data are included on each municipality of county covered in the report, and there are five appendices followed by a list of references.

68-0253

Solid waste production. In A study of solid wastes disposal and their effect on water quality in the San Francisco Bay-Delta Area. [Sacramento]. California Department of Public Health, 1968. p.3.1-3.10.

The term solid waste here includes all solid or semisolid waste material having little or no value. In addition, the term includes demolition waste, street sweepings, sewage treatment residue, industrial solid wastes, agricultural manure, crop wastes, and other miscellaneous materials. Solid waste production in the Bay-Delta area has been grouped into three general categories: municipal wastes, industrial wastes, and agricultural wastes. The total amount of waste generated in the Bay-Delta area was determined by analyzing each segment (municipal, industrial, and agricultural) separately with a summation made of all segments for the total. Considerable use was made of waste generation factors. These factors generally relate the average quantity of waste produced over a period of time to a basic unit of production. Factors such as lbs-per-person-per-day were utilized for municipal waste. Several tables are given for present waste production in each of the above three areas, as well as projected figures up to the year 2000. Population growth for the area is projected in 10-year increments. The annual solid waste production in the study area is expected to increase from 13.8 million tons per year in 1967 to almost 30 million tons per year in 2000. There is also presented a county-by-county analysis of projected municipal solid waste production in Appendix A, and in table 3.10, a projection is made of agricultural waste production to the year 2000.

68-0254

Solid waste disposal. In A study of solid wastes disposal and their effect on water quality in the San Francisco Bay-Delta Area. [Sacramento]. California Department of Public Health, 1968. p.4.1-4.42.

Seven factors are listed which may affect the type of disposal method utilized for solid waste. Methods of disposal for the San Francisco Bay-Delta area are listed and described. The landfill method is the most widely used throughout the area, sanitary landfill being the most acceptable form from a public health standpoint. The usual form in this area however is some type of modified landfill. Incineration has not been utilized to any great extent, and no municipal incinerators were operating at the time of this report. Composting cannot be considered an ultimate disposal means, since the inorganic material must be disposed of by other means. As a result, composting is very limited in application in the Bay-Delta area. Grinding units have been installed in most commercial establishments throughout the area and have given

satisfactory results. Salvage and reclamation cannot be considered exclusively as a means of disposal, but metals and other materials are salvaged to some degree in the area. Fifteen hundred tons of cans per month are salvaged and reclaimed for use in the copper industry. Ocean disposal of municipal refuse is no longer practiced because of cost and the threats to recreational uses of the coastal areas. Open burning is practiced only outside the Bay Area Air Pollution Control District. Pyrolysis is used at only two plants in the Bay-Delta area. Garbage feeding to hogs has decreased greatly in recent years. The counties are deficient in their planning. Some counties have no active program relative to solid waste disposal under their planning. Only five have some kind of joint or cooperative program with another county or city. Ten of the counties have solid waste ordinances, eight of which have standards for disposal site operation. Only four include requirements to protect water quality. Disposal sites are classified, and disposal site description data is given in Table 4.4. The remaining capacity of the active sites still available for use is about 219,000 acre ft. Only 11 of the 103 General Use Disposal Sites were classified as sanitary landfills.

68-0255

Influence of solid wastes on water quality. In A study of solid wastes disposal and their effect on water quality in the San Francisco Bay-Delta Area. [Sacramento]. California Department of Public Health, 1968. p.5.1-5.51.

When solid waste residues of any type are disposed to the soil, a potential water quality impairment exists. Even if a solid waste is incinerated, the ash will contain soluble substances which may dissolve in runoff and percolating water and thereby affect the quality of the adjacent surface water or underlying ground water. The principal problems produced by solid wastes involve leached materials, changes in the characteristics of waters exposed to decomposing solid waste, and gaseous end products which result from the decomposition of organic materials. Closely related to the solid waste problem is the disposal of small quantities of liquid and semisolid materials; these are very difficult to manage. A great deal of discussion was given to changes in estuarine water during contact with tideland disposal site fills. Tidal changes can cause a backflow of water from the bays into estuaries, with resultant pollution if these bay areas are locations of waste disposal fills. These fill areas themselves often become anaerobic since all available oxygen may be consumed by the biota active in decomposing the organic matter of the fill. Leachate from solid wastes is discussed at length, and the effects on surrounding soil and water if such leaching occurs. Gas production in solid waste disposal sites is discussed with its effects on water quality. A comprehensive section on the Bay-Delta disposal sites' water quality is included, as well as a section on the criteria used in the evaluation, along with background information.

68-0256

Present effects of solid waste disposal on water quality in the study area. In A study of solid wastes disposal and their effect on water quality in the San Francisco Bay-Delta Area. [Sacramento]. California Department of Public Health, p.6.1-6.39.

Water samples were collected at seven solid waste disposal sites to obtain estimates of the types and amounts of

materials discharged from the disposal sites which could cause impairment of the quality of the water of the bay and delta. Various water situations were noted at these sites, including drainage leaving fills at low tide conditions, discolored water adjacent to fills, water passing through levee systems, leachate emerging from fills, and placement of wastes directly into the water. The disposal sites considered were those in Albany, West Contra Costa, Acme Fill, Alameda City, Palo Alto, Davis Street, and South San Francisco. Each is adjacent to the bay system, and the results of each study were given in detail. To determine the presence and range of volatile fatty acids in typical landfill leachate, a series of samples was analyzed using gas chromatography. Eleven samples were tested by the Department of Public Health's Sanitation and Radiation Laboratory. Industrial waste disposal was examined by testing the characteristics of tank bottom wastes disposed at Industrial Tank, Inc.'s, Vine Hill facility. Various pollutants are discharged into the Bay-Delta surface and ground waters, and quantitative estimates were made of pollutant loadings. Such types of material as biodegradable material, floating debris, nutrients, solids, toxic substances, and taste and odor-producing materials were studied. A water quality impairment rating system was developed, since it was not possible to accurately estimate the quantitative pollutant loading imposed on the water from each solid waste site in the study area. Sites were categorized by a rating which estimates the general range of the pollutant loading. In this way, an approximation could be made representing the relative significance each disposal site has on the quality of the water in the Bay-Delta area.

68-0257

Future solid waste management practices and effect on water quality in the Bay-Delta area. In a study of solid wastes disposal and their effect on water quality in the San Francisco Bay-Delta Area. [Sacramento], California Department of Public Health, 1968. p.7.1-7.4.

The solid waste disposal methods currently in use in the Bay-Delta area, will undoubtedly continue to be used in the immediate future. It is difficult to visualize any radically new disposal techniques being used in the next 10 to 15 years. It is expected that landfilling will continue to be the primary means of solid waste disposal for the foreseeable future. Landfill disposal site locations and operating practices are expected to change. It can be fully expected that the use of open tidelands for refuse disposal will generally be prohibited in the future. A trend towards the use of inland canyons or other inland submarginal land for future large disposal sites is anticipated. Longer hauling distances will probably be required in the future, due to relocation of sites to more remote inland areas. Many of the existing landfill sites will be exhausted and completed within the next 10 years. The solid waste production increase, which will occur in the Bay-Delta area as a result of population and industrial growth, will require large disposal volumes. Open dumps however, will undoubtedly be prohibited in the study area within the next few years. The next 10 to 15 years will see an increasing interest in incineration of solid waste. A very favorable potential for expanded use of grinders for the disposal of refuse to existing sewers will also develop. Other processing methods such as composting, pyrolysis, or destructive distillation are not expected to be utilized to any large extent in the foreseeable future in the Bay-Delta area. In terms of

solid waste management, there is a growing pressure and trend toward regional management of wastes. Regarding future water quality in the Bay-Delta area, the consensus is that water quality hazards or threats from solid wastes will actually lessen as improved disposal techniques and greater management controls are effected. The major threats will come from land disposal sites. Preliminary guidelines for solid waste management to protect water quality have been prepared for many specific wastes.

68-0258

Stumpf, H., and W. Schleuter. Basic considerations on the role of planning in the disposal of waste. *Elektrizitätswirtschaft*, 67(18):517-521, Aug. 1968.

Presently about 8.5 to 9 million tons of waste accumulate annually in the Federal Republic of Germany. Of these 92 percent are dumped, 5 percent are deposited in sanitary landfills, 2.3 percent are incinerated, and 0.7 percent are composted. The increase in wastes over the last 10 years is illustrated in a diagram. The federal laws concerning the dumping of wastes are briefly reviewed. The specific amounts of wastes of some West German cities and municipalities are listed. Before a municipality decides on a type of waste disposal, extensive preliminary investigations are absolutely necessary. First, the types of wastes that accumulate in the respective municipality must be determined as well as the amounts. Questionnaires are to be sent out for this purpose. An analysis of the wastes helps to determine whether they are putrescible and are thus suited for composting or how combustible they are. Moreover, the location of the site for the composting or incinerating plant must be carefully considered. Easy access, closeness to the place of accumulation, the existence of a sewage plant nearby, etc., are all essential criteria for choosing a site. As far as incinerators are concerned, it must be pointed out that the higher the capacity of the plant the more economically it will operate. The laws limiting dust emission must be studied. It must also be determined what end products are left, and how they are eliminated. A decision must be made on how to use the heat or whether to use it at all. The costs of various methods must be compared. There is a considerable difference in investment costs involved in various types of incinerators. The recommended costs lie between 50,000 and 100,000 DM. (Text in German)

68-0259

Talbot, J. S. Some basic factors in the consideration and installation of deep well disposal systems. *Water and Sewage Works*, 115(R.N. 1968):R213-R219, Nov. 29, 1968.

Three major considerations in deep well disposal are: economic, public relations, and legal factors. The deep disposal system consists of a well or wells and surface equipment including treaters, tanks, filter, pumps, transfer piping, and controls. The principal limitations of deep well disposal are those of geology and the nature of the waste. Wastes with a large amount of suspended solids which are difficult to remove or which are unstable or incompatible with the injection formation are usually considered unsatisfactory for injection into the subsurface. Suspended solids may be removed by sedimentation or filtration. Some formations will accept particulate matter if they possess

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fracture or vulgar permeability, or if fractures may be extended or induced by injection pressures. An example is given of the operation of activated sludge disposal wells at Midland, Michigan. The cost of well systems vary from less than \$20,000 to well over \$1,500,000. If proper care is not taken in the design and construction of the system, pollution or other damage may be caused to potable surface or ground water supplies and to commercial mineral resources. In many cases, deep well disposal is the best and cheapest technique that can be used.

68-0260

Thompson, M. Control of environmental pollution: the problem of solid wastes. In N.I. Sax. *Dangerous properties of industrial materials*. 3d ed. New York, Van Nostrand Reinhold Company, 1968. p.128-132.

The solid wastes problem consists of the storage, collection, transportation, and disposal of unwanted wastes from residential, commercial, industrial, and agricultural sources. Such wastes include not only solids, but also the liquid component of industrial and institutional wastes which, for various reasons, are not handled by liquid waste treatment facilities. Composting is a volume reduction method for handling refuse. It produces final products which must be disposed of by sale, incineration, or sanitary landfill. Incineration is not a method of disposal; it merely reduces the total volume of wastes by 80 percent. An extension of the sanitary landfill technique is the utilization and reclamation of abandoned strip mines, salt caverns, quarries, etc. The organization and administration required to handle the total unwanted wastes problem efficiently for a community can vary considerably. Comprehensive studies by an experienced and competent engineering firm are necessary if communities within an economic service area are to be served individually and collectively by the most efficient collection, transportation, and disposal system. Comprehensive studies must identify and present and future problems and provide alternative solutions.

68-0261

Treatment and disposal of wastes. *Public Cleansing*, 58(2):62-64, Feb. 1968.

The views of a group of experts who met in Geneva in December, 1966, to discuss problems on the treatment and disposal of wastes are contained in a WHO report. The pretreatment of industrial waste, or means for burying toxic liquid chemicals, should be considered for waste waters which should not be handled at a municipal sewage plant. The production of solid wastes is increasing and is presently at least 700 kg per capita per year. This fact, combined with the changing nature of the wastes themselves, requires further research into the design of furnaces and in the methods of dealing with refuse. Efforts should be intensified to persuade manufacturers to provide means of reducing wastes at their source. The group found that further research is needed in the field, and research funds should be an integral part of provisions for the construction and operation of plants for the management of wastes.

68-0262

Wasserman, L. P. Marine pollution on the continental shelf—helpful or harmful? In *National Symposium on Ocean Sciences and Engineering of the Atlantic Shelf*, Delaware Valley Section, Phila., Pa., Mar. 19-20, 1968. p.339-343.

As land area for dumping becomes scarce, schemes are being proposed to solve the problem by disposing of wastes at sea. Planning and control, coupled with research into oceanic waste disposal can turn this potential threat into a great asset. Using proper disposal techniques, wastes can serve as a source of nutrients, shelter, and breeding grounds for plant and animal life. But is it not known what concentration can be called food and what concentration is toxic. The situation in the ocean is complicated by currents, animal life, and our limited knowledge of marine ecology. Some major areas for investigation are considered. With adequate supervision, the wastes of society can be dumped or pumped onto the continental shelf in a manner that will improve the land, sea, and air of this planet.

68-0263

A waste/sludge composting plant for Heidenheim, West Germany. *Staedtehygiene*, 19(8):178, Aug. 1968.

The city council of Heidenheim, West Germany, decided to place an order with Voith Mullex GmbH for the construction of a composting plant with incineration. The plant will take care of all the wastes accumulating in the city including sewage sludge, bulky wastes, and wastes from abattoirs. The plant has been designed for a population of about 60,000, but it can also process the wastes for the neighboring villages without any extension. The waste is shredded according to the Dorr-Oliver method. The composting process is performed according to the open air method newly developed by Voith. The capital investment costs for the plant alone, without land costs, is estimated to be 3.5 million DM. (Text in German)

68-0264

Watson, J. L. A. Master plan for town refuse disposal. *Public Cleansing*, 58(4):161-165, Apr. 1968.

Stage one of a master plan for town refuse disposal is a study of the Greater Tel Aviv area by a consultant experienced in problems of this character. The consultant will work under the direction of the Inter-Ministerial Committee for the Disposal of Town Waste. The Ministry of Health will supply all relative information in its possession through the Sanitation Division and District Health Departments. The four objects of the study are: determination of the degree of inadequacy of the present methods of waste disposal; assessment of the magnitude of the problem and its expected growth; analyzing various disposal methods suitable to Israeli conditions; and proposing a solid waste disposal system. The following types of solid wastes were surveyed: domestic refuse, bulky refuse, market refuse; and industrial waste. The composition, weight, volume, and moisture content of domestic refuse will be determined. Disposal sites for sanitary landfill will be located.

68-0265

Work group for waste disposal founded. *Rohr-Armatur-Sanitär-Heizung*, 23(2):144, Feb. 1968.

At a meeting in Frankfurt, Germany, on October 31, 1967, the Workgroup for Waste Disposal (AFA - Arbeitsgemeinschaft fuer Abfallbeseitigung) was founded. It was immediately joined by nine associations which are active in the field of solid waste disposal and water pollution control. The names of these organizations are listed, and the opinion is expressed that additional groups would join. (Text in German)

68-0266

Young, R. Deep well disposal-cure all or troublemaker? *Plant Engineering*, 22(23): 126-128, Nov. 14, 1968.

The fundamentals of deep well disposal are those of geology and the nature of the waste. Surrounding the disposal rock section must be impermeable rock that will contain the liquid waste. The injected liquid must be of low viscosity, and metal content, have very small amounts of suspended solids, a pH of less than the brine in the formation into which it is pumped, a high specific gravity, and the liquid should not have any self-polymerizing materials, bacteria, or dissolved gases. Each well varies in cost, depth, and type of material accepted. Extensive engineering studies must be undertaken before a well can be drilled. Illustrations include areas in the United States where injection is feasible, some data on wells already in operation, problems encountered, and a typical deep well installation.

AGRICULTURAL WASTES**68-0267**

Adams, A. D. Bulking of dairy waste activated sludge. *Water Research*, 2(10):715-722, Nov. 1968.

The phenomenon of bulking of a dairy waste activated sludge was studied in relation to known and estimated data concerning two types of microorganisms involved in the mechanism of bulking, *Sphaerotilus*, and *Arthrobacter*-like bacteria. Reduced oxygen supply, resulting from the high dissimilation rate of the carbohydrate fraction of the dairy waste, along with the ability to accumulate storage compounds and the discrepancy between the potential and actual carbon to nitrogen ratios of this waste, were considered to be the main factors in stimulating growth of *Sphaerotilus*, and thus to be responsible for bulking. Alteration of the nutritional conditions caused an improvement of the growth of *Arthrobacter*-like bacteria, and this led to a pronounced relative suppression of *Sphaerotilus*, resulting in the restoration of the settling properties of the sludge.

68-0268

Adams, A. D. Formation and final composition of the bacterial flora of a dairy waste activated sludge. *Water Research*, 2(9):665-671, Oct. 1968.

The formation, as well as the final composition of the bacterial flora of dairy waste activated sludge was studied

systematically, using a well-defined dairy waste as the substrate. A comparison of the bacterial flora of the dairy waste activated sludge developing from the initial to the optimal stage in an oxidation ditch and in a laboratory apparatus, showed a close similarity between both systems, so that the latter may be used for representative experiments. Adaptation of the bacterial flora to the supplied waste was found to be a slow process. The composition of the flora altered with time until, ultimately, it consisted predominantly of coryneform (*Arthrobacter*-like) bacteria. Next to these, considerable amounts of *Achromobacteraceae* were found. *Pseudomonadaceae*, initially present in large numbers, dropped to the least important of the three major groups of bacteria. The alteration of the bacterial groups coincided with an alteration of the physiological characteristics of the total activated sludge flora. In the final state, two-thirds of the isolated bacteria gave a neutral reaction on Hugh and Leifson media and more than half were nonproteolytic. This is in agreement with the predominant position held by the group of coryneform, particularly *Arthrobacter*-like bacteria. The brown color of the activated sludge may be attributed to *Flavobacteria*.

68-0269

Adams, A. D. Response of dairy waste activated sludge to experimental conditions affecting pH and dissolved oxygen concentration. *Water Research*, 2(10):703-713, Nov. 1968.

When activated sludge was fed a normal amount of artificial dairy waste, a sharp drop of pH and dissolved oxygen (DO) was observed immediately due to the ready dissimilation of the carbohydrate fraction of the substrate. Decomposition of the protein fraction started later, proceeded at a much lower rate, and was accompanied by a slight fall of pH and DO for a more prolonged period of time. The drop of pH during dissimilation of the carbohydrate fraction was caused by a transitory occurrence of acid intermediates in the suspension. This was assumed to be due to the fact that, in spite of very vigorous aeration, the oxygen absorption rate was unable to meet the increased demand for oxygen and therefore, the oxygen absorption rate became a limiting factor in the oxidation of the carbohydrate fraction of the substrate. The difference found between the dissimilation rate of the carbohydrate fraction and that of the protein fraction caused a discrepancy between the potential and actual carbon to nitrogen ratios of the substrate. Analyses of the acid intermediates showed that acetic acid was accumulated in the activated sludge suspension when DO was present, whereas lactic acid was found when DO was absent.

68-0270

Aguila, N. The effects of burnt canes and trashes on factory operations. *Sugarland*, 5 (3):13, 32, 35, Apr. 1968.

Although planters contend that burning canes facilitates harvesting, eradicates pests, and gets rid of trash, the author, representing the miller's point of view, argues that burnt canes result in low sugar recovery, high molasses production, delay of work in the boiling house, and definite loss in milling capacity. According to Deomano (1956), burning canes destroys material in the fields that are potential humus for the soil. The effects of non-sugar in the processing operation is discussed. Raw sugar crystallized from burned

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cane juice is believed to have poor refining qualities with poor filterability, color, and friableness. Large amounts of trash (any material delivered to the factory in conjunction with cane from which no sugar is obtainable) has detrimental effects on the entire sugar factory operation. The weight of the trash reduces the percentage of sucrose in the milled cane. Trash lowers the capacity of the mill, and introduces impurities which change boiling house control calculations and slow down clarification. It lowers the efficiency of inhibition, increases the fiber in cane, and reduces sucrose extraction. It is suggested that the milling contract include the provision that burnt sugarcane should be accepted only upon special agreement, between the parties, with respect to conditions under which the sugarcane should be milled.

68-0271

Animal waste utilization group formed in Canada. *Compost Science*, 9(3):17-18, Autumn 1968.

The Utilization of Animal Wastes Committee of Ontario, Canada, headed by L. R. Webber, has adopted the following program: a pilot study of livestock density and land for disposal; investigation of areas of future development; management practices in handling solid, slurry, or liquid manures; odor control and abatement in rearing areas, and storage facilities; health problems; and study of land areas for disposal. In a paper presented at the Eighth Industrial Water and Wastewater Conference in Lubbock, Texas, June 1968, guidelines to land requirements for disposal of liquid manure were presented. The committee has prepared a table showing the land requirements for two levels of manure applications on corn land. The quantities of phosphorus and potassium, that reach the ground water from manured cropland, appear to be insignificant, but nitrogen applications may contribute significantly to ground water pollution.

68-0272

Axtell, R. C. Integrated house fly control: populations of fly larvae and predaceous mites, *Macrocheles muscaedomesticae*, in poultry manure after larvicide treatment. *Journal of Economic Entomology*, 61(1):245-249, Feb. 1968.

The population of 3rd-instar larvae of house fly, *Musca domestica* L., and adults of *Macrocheles muscaedomesticae* (Scopoli), which are predaceous on the eggs and 1st-instar larvae of the house fly, were determined at intervals before and after the application of 12 insecticides to the manure under caged laying hens. Selective toxicities which could be used to advantage in larvicidal fly control were not found. The few chemicals which did not destroy the mite population gave very little control of fly larvae, while those which gave some control of fly larvae (for periods up to 2 weeks) were deleterious to the mite population. The mite population increased very slowly following decimation by insecticide treatment, while the numbers of fly larvae increased rapidly. It was concluded that larviciding of the manure with nonselective insecticides is detrimental to mite predators of the immature stages of the house fly, and should not be practical. Selective application methods for adult fly control are preferable and efforts to refine these methods should be intensified. Very temporary control of fly larvae may be accomplished with some chemicals, but the resurgence of the fly population is rapid. In the absence of manure inhibiting,

predaceous, mites, the fly problem may become greater than it was originally. Integrated control of the house fly is not yet a reality.

68-0273

Cassell, E. A. Studies on chicken manure disposal. Part 2. Chemical dewatering. Albany, New York State Department of Health, May 1968. 244 p.

The feasibility of the use of chemical dewatering techniques for the disposal of chicken manures was investigated in three studies on: the generation of cost data for the application of vacuum filtration to chicken manure treatment; dewatering of chicken manure by centrifugation; and dewatering of chicken manure by a hydraulic press. The total annual cost for dewatering chicken manure by vacuum filtration varied from \$0.20 per bird per year to an excess of \$1.20 per bird per year. The total annual cost decreased with increased farm size. Chemical costs were estimated to be \$0.20 per bird per year. The solid-bowl centrifuge appeared to be best suited for dewatering diluted manures, such as manure from liquid handling processes. The cationic polyelectrolyte used did not significantly effect the solids content of the cake but did improve the recovery of the chicken manure. The hydraulic press was found to be well adapted to small farm use because of its operational simplicity and ability to be adapted for intermittent or batch use. The press cakes from the hydraulic press had a total solids content of 45 to 55 percent. The addition of polyelectrolytes did not appear to increase the total solids in the press cake.

68-0274

Compaan, J. P., and E.J.B. Bishop. Pineapple fruit waste as silage. *Farming in South Africa*, 44(1):28-29, Apr. 1968.

The fruit canning factories in Port Elizabeth and East London produce between 50,000 and 70,000 tons of pineapple fruit waste annually. The waste from pineapple fruit processing, including the outer peels and cores of the pineapple, make very acceptable silage. Dehydration of the waste is expensive but produces a stock feed called pineapple bran. Silage of the material and dehydration for periods of more than three weeks produces very acceptable silage. Dry matter content is low for normal silage (14%) and the concentration of nutrients is also low. The silage has to be supplemented with the nutrients in other forms. Shrinkage on the order of 48 percent makes hauling costs significant in use of this product. Copious run-off of juice is experienced during silaging. This requires good drainage.

68-0275

Control and Disposal of Cotton-Ginning Wastes; a Symposium, Dallas, May 3-4, 1966. Public Health Service Publication No. 999-AP-31. Cincinnati, U.S. Department of Health, Education, and Welfare, 1967. 103 p.

A symposium on the problems on cotton-ginning wastes was sponsored by the National Center for Air Pollution Control of the Public Health Service and the Agricultural Engineering Research Division, Agricultural Research Service, U.S. Department of Agriculture. Technological changes in cotton harvesting and cotton ginning and the wider use of pesticides,

desiccants, and detoliant chemicals in cotton production suggested the need for the conference. The proceedings contain information on the following subjects: the roles of local, State, and Federal agencies in controlling air pollution; the roles of the State extension's gin and mechanization specialists; methods employed in harvesting cotton; operations and characteristics of the cotton gin; trash disposal practices; methods of collecting lint cotton trash; air pollution studies of cotton gins in Texas; trash collection and disposal systems; the design and operation of the in-line filter; consideration for determining acceptable ambient and source concentrations for particulates from cotton gins; and recommendations for needed research and development.

68-0276

Dale, A. C. Disposal of dairy cattle wastes by aerobic digestion. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint D-6.)

Specific determinations that should be carried out in the development of an aerobic digestion system for the disposal of dairy cattle wastes are: chemical composition, physical characteristics, and the undigested contents of the wastes; effect of temperature on the aerobic digestion rate of the wastes; loading rates of dairy cattle wastes to the water that will permit satisfactory biological decomposition when the mixture is supplied with air; separation of undigested feeds and foreign matter from manures; adaptation of a known oxygenation system; and separation of digested sludge from the effluent. One oxidation ditch, with a rotor aerator operating under a slotted floor in a free stall dairy barn, and a floating aerator in a waste lagoon, is being tested. Laboratory work under way consists of several digestion studies to determine factors affecting the degradation of manure such as: loading rates, time, temperature, particle size, and bacterial culture inoculants.

68-0277

Das Gupta, P. C., and A. K. Mazumdar. Jute stick cellulose as a raw material for industrial nitrocellulose. Research and Industry, 13(3): 152-153, July-Sept. 1968.

The possibility of using jute stick, which is rich in cellulose (about 46%), as an alternative starting material for nitrocellulose production has been investigated. About 2 million tons of jute stick is available in India each year as an agricultural by-product. Procedures have been worked out, on a laboratory scale, for the production of lacquer-grade and celluloid-grade nitrocellulose. The characteristics of the nitrocellulose prepared from jute stick show close conformity with the relevant Indian Standards Specifications.

68-0278

Day, D. L. Oxidation ditches for waste disposal. International Journal of Farm Building Research, 3:2-7, Dec. 1968.

The oxidation ditch is an efficient, low-cost process for the treatment of municipal waste. Several of its aspects make it seem desirable for use in a confinement livestock waste-treatment system. The aerobic method is an odorless

process whose final products are water, carbon dioxide, and stable minerals. The oxidation ditch can be integrated into a self-cleaning, slatted-floor system. However, control of foaming is an immediate problem that must be solved before the process can be unconditionally recommended. Operational criteria must be developed if the method is to serve for complete treatment of livestock manure, with an effluent that can be accepted by public health and water board standards. It should be recognized that control of odors emanating from dung cellars does not necessarily insure an odorless building, as odors can be liberated from the surfaces of slatted floors. Adaptations of the oxidation ditch for the treatment of livestock manure are forthcoming, in view of the intense research that is in progress in the United States and abroad. However, until the current problems are resolved, the disposal of livestock manure in a manner that does not create an odor nuisance and a water pollution hazard remains a complicated problem. It appears that an additional stage of treatment will be necessary if an effluent is to be produced which is up to public health and water board requirements for discharge into a water course. Removal of solids to a secondary stage of treatment, or extended aeration in another oxidation ditch might be possible for achieving complete stabilization. Poor settling characteristics of the sludge usually accompany incomplete treatment.

68-0279

Day, D. L., D. D. Jones, and J. C. Converse. Field testing the oxidation ditch for swine waste. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint E-4.)

Severe foaming, poor sludge settling characteristics, brief periods of ammonia release, and incomplete treatment are some problems that need further research if oxidation ditches are to adequately treat livestock waste. A satisfactory low odor condition in the oxidation ditch has been achieved in many field tests. Surplus sludge can be spread as a slurry or irrigated without objectionable odor if the disposal is made before the sludge has a chance to turn septic. The principal parts of an oxidation ditch are described and illustrated in a schematic diagram. Swine waste has a much greater concentration of organic matter and fibrous lignaceous material than municipal waste. The BOD of liquid hog manure is usually 30,000 to 50,000 ppm. A second building on the University of Illinois swine farm has been equipped with an oxidation ditch. The rising amount of sludge has been utilized in a field test to separate solids in an indoor oxidation ditch.

68-0280

Dugan, G. L., C. G. Colucke, and W. J. Oswald. Photosynthetic reclamation of agricultural solid and liquid wastes. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint E-1.)

The object of this research is to convert agricultural wastes now causing environmental problems into reclaimable material. A detailed study will be made of the basic characteristics of an integrated anaerobic fermentation and

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algal growth system for agricultural wastes on a pilot plant scale. Reaction kinetics and overall performance of an anaerobic reactor or pond, followed by an algal growth reactor or pond, will be studied. Recirculation of algae-free effluents will be employed for odor control and nutrient transmission. Chicken manure was selected as the waste to be used in the first part of the project. Experiments conducted so far show that dried manure is digested only with difficulty and that gas production is lower than that obtained when wet manure is used. The design and construction of the pilot plant is outlined.

68-0281

Esmy, M. L., and J. S. Boyd. Drying as a means of animal waste management. *Proceedings, American Petroleum Institute, Division of Refining*, 48:82-89, May 1968.

Drying as a system of waste management can be applied to all types of manure and provides an end product which can be stored indefinitely and causes no air or water pollution. Reducing the moisture content of manure from approximately 75 percent to 5 to 10 percent for purposes of utilization or disposal shows promise. An experimental drier for this consists of sloping trays which vibrate, letting the manure migrate downwards against an updraft of heated air. An experimental test showed a total cost for 357 lb of wet poultry manure of 69 cents per hr and a weight reduction of water vs. wet weight of 76.7 percent. A ton of dried manure would cost, for fuel and electricity, \$16.60 to produce. Depreciation and fixed costs would increase this total to between \$20 and \$25. An analysis showed that 44 percent of the non-protein nitrogen was lost during the drying process. Dried poultry manure is estimated as being salable at approximately \$20 per ton. Thus drying is suggested as a way of minimizing environmental degradation and providing opportunities for use of manure as fertilizer where wet solid or liquid manure would be unacceptable.

68-0282

Farm wastes. *Water and Waste Treatment*, 12(4):131, Nov.-Dec. 1968.

Experiments carried out in Holland on the aerobic treatment of farm wastes were continued under a research grant from the Ministry of Traffic and Water Affairs. Three experimental plants began operation at the end of 1967 and three privately owned plants are in operation: oxidation ditches lined with plastic or bituminous material, an oxidation tank of reinforced concrete, and a reinforced concrete ditch. The only correct basis on which to design an extended-aeration plant for treating farm waste is the BOD loading per kg per day. The capacity of the ditch or tank can be calculated, assuming a minimum mixed liquor suspended solids concentration of 6000 mg per liter. It is cheaper to operate plants of this type on an intermittent basis, with the aerator being stopped and sedimentation taking place in the ditch or tank before the effluent is discharged.

68-0283

Gibbons, J. Farm waste disposal in relation to cattle. *Water Pollution Control*, 67(6): 622-626, 1968.

Changes in the pattern of farming such as the development of silage feeding systems, the larger numbers of animals per man

employed, and the greater density of livestock per acre, have affected the nature of the manure disposal problem. Dairy cows cause the main problems of waste disposal. With the advent of cubicle-housing/low-labor systems, the traditional methods—using straw to absorb the liquid, or piping the manure to a liquid-manure tank or blind ditch—have become inadequate. The manure now has to be handled as slurry which inevitably means organic irrigation. Recently the spreader-tanker is giving place to a manure spreader which can deal with firm slurry. Care must be taken to exclude silage effluent from farm drains, and to avoid the possibility of its seeping into ground water supplies. Factors affecting the choice of housing systems and methods of effluent disposal are considered.

68-0284

Gin trash curbs wind erosion. *Agricultural Research*, 17(6):15, Nov. 1968.

Application of gin trash to exposed loamy fine sand may help cotton farmers cut wind erosion losses and also reduce waste disposal problems at the gin. Applications of 0, 1, 2, 3, 5, 7, and 10 tons per acre of trash were tested. The 5-ton application, considered the best, completely covered an acre and cut soil losses 87 percent. The 3-ton rate cut soil losses 67 percent. Plots of ten 40-in. rows, 15 ft long were used. Although the trash was spread by hand in tests, a standard manure spreader could apply up to 20 tons per acre. Test plots were subjected to wind velocities equal to 55 miles per hr.

68-0285

Gunary, D. The availability of phosphate in sheep dung. *Journal of Agricultural Science*, 70(1):33-38, Feb. 1968.

Sheep grazing good pastures may void 7 to 8.5 lb phosphate per head per year in dung. The fertilizing value of this substantial amount of phosphate is of practical interest. The amount of labile phosphate released in two soils from incorporated sheep dung (of two phosphate levels) was determined in a pot experiment. The inorganic phosphate in dung was initially highly available, but it diminished in value after a period of contact with soil. The organic fraction of the phosphate had only small availability. A further pot experiment where dung was applied to the surface of the two soils indicated that, although dung phosphate may be readily available, its value for grass depends on good contact between the dung and the roots.

68-0286

Haines, M. Slurry storage—under high rainfall conditions. *Agriculture*, 75(6):281-284, June 1968.

The advent of cubicle housing for dairy cattle has brought to many farms the problem of slurry storage and handling, especially in a flat land area with high rainfall. A workable system was designed for a farm that had to provide slurry storage for a period of at least 8 weeks for a herd of 48 dairy cows housed in cubicles bedded with sawdust and shavings. The layout and operation are described in detail. A pit 36 ft square was excavated to a maximum depth of 2 ft and lined with concrete blocks to a height of 2 ft above ground level. A concrete apron 12 ft long was provided for the easy access of

machinery to empty the pit. This experience indicated that in constructing such a pit, approximately 120 cu ft capacity per cow should be provided for 60- to 70-day storage. The slopes must be satisfactory, with the ramp sloped not more than 1 in 9, and with the fall in the pit floor about 1 in 24. The areas where the slurry is produced should be covered, and drainage water and long fodder must be excluded from the pit. The pit should be emptied whenever the weather is suitable for field spreading.

68-0287

Hart, S. A. Agricultural wastes management in the future. *Agricultural Engineering*, 49(12): 729, 752, Dec. 1968.

Three areas in which improved agricultural waste management will be necessary in the future include: livestock and their wastes; crop residue problems; and municipally generated wastes disposed of agriculturally. Manure problems occur when, for example, the livestock farmer confines 5,000 to 50,000 animals in a feedlot of 25 to 200 acres about 4 miles from a city, and when a poultryman confines 100,000 chickens in cages with $\frac{1}{2}$ sq ft of floor space per hen. The main limitation in manure management today is economics. The problem of odor control needs further study. The mechanization of crop harvesting has created problems in residue management and especially in tomato picking where spoiled fruit is left to rot in the fields. Municipal solid wastes can be disposed of economically by making a poor grade of compost to be spread onto a specially reserved small parcel of land at the maximum assimilation rate. Someday in the future this land could be returned to agriculture or converted to subdivisions. Questions of irrigation, drainage, leaching, and pH control need to be answered. Training the engineer in sanitary engineering, combined with an agricultural engineering specialization, is recommended.

68-0288

Hunt, P. G., and T. C. Peele. Organic matter removal from liquid peach waste by percolation through soil and interrelations with plant growth and soil properties. *Agronomy Journal*, 60(3): 321-323, May-June, 1968.

To determine the effectiveness of the soil in reducing the BOD of liquid peach cannery waste and the interrelations of the waste with soil properties and plant growth, peach cannery waste of three concentrations was applied to Cecil sandy clay loam and Lakeland sand. Lysimeters were used with Coastal bermuda grass. The soil was artificially placed in the lysimeter to simulate sub-soiling to a depth of 50.8 cm. The waste was applied at a rate of 2.54 cm per hr with total amounts of 7.62 cm twice a week. No ponding was observed, indicating an infiltration rate of at least 2.54 cm per hr. A total of 82.55 cm of waste was applied during the season. The BOD was reduced 98 percent by the Cecil and 64 percent by the Lakeland soil. Yield of the grass decreased somewhat as the waste increased, but was higher in all cases than the non-irrigated controls. Application of the waste increased the exchangeable sodium in the soil, but no appreciable effect on soil structure was found.

68-0289

Ishida, M., and T. Shirai. Fluidized incineration of chicken droppings. *Kagaku Kogaku*, 32(5): 459-463, May 1968.

The design of the fluidized-bed incinerator is shown in a diagram with the dimensions, materials, and parts identified

in English. The experimental ranges for the incineration of chicken droppings are given in a table (also in English). The temperatures recorded after the deposit of chicken droppings on the fluidized bed are shown in a graph. Formulas are developed for the theoretical heat loss, the heat transfer rate from chicken droppings to bed, and the weight of the final product. The nomenclature used in the development of all these formulas is defined in English at the end of the article.

68-0290

Johnson, R.D. New process transforms corn wastes to protein feed. *Chemistry in Canada*, 20(12): 39-40, Dec. 1968.

Laboratory experiments determined the controls necessary to give yeast a competitive growth advantage in waste treatment. In treating unpasteurized corn processing wastes, the only difference from the activated sludge process was the control of pH and the presence of sulphur dioxide in the waste. With a pH between 4.0 and 5.0, and temperatures 22 to 30 C, only the yeast appears to grow. At a pH range of 5.5 to 7.0, the biomass became mainly bacterial, and many of the normal activated sludge organisms were found. The yeast can be used as a high protein feed material or be blended with an existing corn gluten feed material.

68-0291

Jones, K. B. C. Farm waste management - lessons from America. *Agriculture*, 75(5): 213-218, May 1968.

Disposal of farm wastes is briefly considered, comparing the United States and the United Kingdom. Methods of disposal of waste on land and operations utilizing partially treated municipal sludge on forest plantations for irrigation purposes are described. Use of lagoons was considered disappointing since a simple lagoon was not capable of digesting a reasonable volume of solids for an extended period. Extended aeration, including the Pasveer ditch, is considered, but the lengthy times involved and the volume of waste to be treated would probably make this uneconomical. Planning to reduce the waste problem including proper location of farms and adequate attention to disposal is essential to waste management. Research into the nature of farm wastes is encouraged to develop further methods of dealing with it.

68-0292

Krane, D. Experiences with the elimination of annoying odors. *Wasser, Luft und Betrieb*, 12 (8): 482-483, Aug. 1968.

The Federal Republic of Germany has several chicken farms with 200,000 to 500,000 chickens. One chicken produces about 200 g of manure per day; thus a farm with 200,000 chickens has a daily accumulation of 4 tons of manure. Some of the manure is used as fertilizer. But the agricultural demand of manure varies with the seasons. The farmer, however, must be able to get rid of his manure at any time of the year since it cannot be stored. To solve the problem, attempts have been made to convert the manure, which has a water content of 75 to 80 percent, into a dry, odorless fertilizer. The manure is very often dried at temperatures between 400 and 850 C. Due to the decomposition of nitrogen-containing organic substances, a process which begins at a temperature somewhat above 100 C, intensive odors develop. To avoid this, a new drier has been constructed. It is heated with steam. A group of pipes runs through a sheet steel pan. The manure falls into the pan and

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is shoveled into the packet-shaped pipe segments. The pipes have a temperature of 140 C. The maximum temperature of the manure is 70 C. The gas arising in this process has a temperature of 90 C. The dust content is reduced in a wet cleaner to less than 50 mg per cu m. Other methods, which tried to render waste gases from manure driers without odor, have not been as successful. (Text in German)

68-0293

Loehr, R. C. Animal wastes; a national problem. Presented at American Society of Civil Engineers Environmental Engineering Conference, Chattanooga, Tenn., May 13-17, 1968. 59 p.

As livestock feed lot operations increase, so will the problems associated with handling, treatment, and disposal of waste. Pollution caused by wastes from animal production facilities can be detrimental to the environment. Education and training activities are vital to the successful attack on the animal waste problem. Coordinated research activities should be initiated to investigate and control the processes for waste handling, production, treatment, and maintenance. Also they should provide detailed data on the quantity and quality of any solid, liquid, or gaseous material that results from these processes as well as feasible ultimate disposal techniques for unitated solids and liquids. Land disposal projects should collect data on crop response, on the effect of pollution caused by rainfall and runoff, and on the maximum quantity of wastes that can be applied to the land. Anaerobic treatment processes are unlikely to be sufficient by themselves. Aerobic systems without preliminary anaerobic units may be feasible with dilute animal wastes. Sanitary landfill is a possibility for dry and semisolid wastes.

68-0294

Loehr, R. C. Pollution implications of animal wastes—a forward oriented review. Ada, Okla., U.S. Federal Water Pollution Control Administration, July 1968. 175 p.

The magnitude of the animal waste disposal problem is discussed, presently applicable technology is examined, and areas where additional information is needed are outlined. Trends in animal and manure production are described in detail. Water pollution and the health aspects of pollution relate to increased production facilities and confinement feeding of animals. Waste treatment and disposal methods include anaerobic digestion, aerobic systems, anaerobic lagoons, land disposal, incineration, and composting. Animal production and waste treatment costs are tabulated, and various treatment processes are compared and evaluated. The authority for the abatement and control of pollution from agricultural sources exists within the Federal government. Recommendations are included for developmental research, field research, and education in the techniques of animal waste treatment and disposal. A bibliography is included.

68-0295

Loehr, R. C. Trends in animal production. In Pollution implications of animal wastes—a forward oriented review. Ada, Okla., U.S. Federal Water Pollution Control Administration, July 1968, p.9-23.

The number of livestock raised for slaughter is expected to increase at about the same rate as the population. The

number of commercial livestock feeding operations will increase as will the numbers of animals per production unit. The north central States will continue to feed the majority of the hogs; the north central, south central, and western States will continue to feed the majority of cattle; the south central and Atlantic regions will continue to raise the majority of the broilers; and the other poultry populations may be fairly well distributed throughout the nation. Because of increased livestock production, increased numbers of production units, and increased numbers of animals per production unit, the problems associated with the handling, treatment, and disposal of wastes from these units are just beginning to be realized, and will be magnified in the future. Statistics are given for: per capita consumption of meat; distribution of hog, cattle, and poultry production; number and capacity of feedlots; and farm and livestock projections.

68-0296

Loehr, R. C. Manure production. In Pollution implications of animal wastes—a forward oriented review. Ada, Okla., U.S. Federal Water Pollution Control Administration, July 1968. p.24-53.

Published values for estimated animal manure production vary due to differences in housing and management practices, type of rations fed, analytical techniques employed, and manure handling and collection techniques. The evaluation of animal waste characteristics is summarized. The trend toward more confinement feeding will create greater concentrations of waste. These wastes will be of a greater pollutational nature as the feed rations slowly change to feeds that contain less roughage and more biodegradable material. A number of States have a per capita equivalent animal population greater than the human population. About half of the beef cattle feedlots have capacities for 2,000 head, and 10,000-head lots are not uncommon. These lots will produce wastes, on a total solids basis, equivalent to that from communities of approximately 36,000 and 182,000 population, respectively. Broiler operations may house from 100,000 to 1,000,000 birds. These operations produce wastes comparable to communities of approximately 10,000 and 100,000 population, respectively. Animal waste production in the United States exceeds that of the human population.

68-0297

Loehr, R. C. Pollution hazards. In Pollution implications of animal wastes—a forward oriented review. Ada, Okla., U.S. Federal Water Pollution Control Administration, July 1968. p.54-68.

Production facilities and confinement feeding of animals have been developed with little planning and concern for the nuisance and pollutational characteristics inherent in the facilities. The economics of pollution and nuisance control in animal production is an important factor and may mean the difference between the success or failure of the facility. Information is lacking on the pollution potential inherent in spreading wastes on land. Both ground and surface water contamination can result as the soluble components, such as nitrates and chlorides, are leached into the ground and as runoff moves a variety of potential pollutants overland. Seasonal, soil, and crop variations determine the maximum quantity of waste that can be put upon the soil without

causing problems. Methods to minimize the nutrient contribution of animal waste treatment facilities and confinement feeding operations for land disposal of solid and liquid wastes are discussed. The color of the liquid fraction from confinement and treatment facilities could be detrimental to discharge and water reuse.

68-0298

Loehr, R. C. Waste treatment and disposal. In *Pollution implications of animal wastes—a forward oriented review*. Ada, Okla., U.S. Federal Water Pollution Control Administration, July 1968. p.69-109.

Coordinated interdisciplinary activities involving sanitary engineers, agricultural engineers, economists, agronomists, and those interested in animal husbandry are needed. Adoption of processes used for municipal and industrial wastewater treatment are not likely to be successful with animal wastes unless process modifications are made for differences in waste characteristics. Because of the quality of animal wastes, anaerobic processes will be a part of many feasible systems treating animal wastes. Anaerobic processes may be controlled and used as manure holding facilities, or controlled to accomplish optimum organic decomposition as well. Aerobic treatment processes can be used, although additional data is needed on the quality of the effluent from the aerobic processes, the effect of shock loading conditions occasioned by slug loading of preliminary anaerobic units, the effect of temperature variations, and the cost of operating and maintaining such systems. Land disposal is becoming less economical due to the large quantity of wastes generated, the costs of transporting the wastes to suitable disposal sites, and the availability of inexpensive fertilizers. Incineration, wet oxidation, and sanitary landfill are possible disposal methods. There is no profitable method of livestock manure utilization. European practices can be a guide for potentially successful American systems.

68-0299

Loehr, R. C. Costs. In *Pollution implications of animal wastes—a forward oriented review*. Ada, Okla., U.S. Federal Water Pollution Control Administration, July 1968. p.110-144.

Size and costs for a number of treatment processes were explored. Combinations of processes will be necessary to meet the needs of specific operations and locations. Since the wastes originate as semisolid material, it may be better to handle and dispose of the wastes as a semisolid, rather than increase the volume to be handled and process it as a liquid slurry. From the size and cost standpoint, simple anaerobic units, mechanical or diffused aeration systems, simplified incineration units, low pressure, wet oxidation, and sub-soil injection of wastes should be explored as potential processes for animal waste treatment and disposal. Although almost no information relating to animal waste treatment processes is available, a summary comparison of the cost of possible treatment units is given. Available data are included for: the cost of cattle feeding operations; the cost of liquid hog manure disposal; and the size of possible anaerobic lagoons, wet oxidation, incineration, composting, and land disposal units.

68-0300

Loehr, R. C. Legal. In *Pollution implications of animal wastes—a forward oriented review*. Ada, Okla., U.S. Federal Water Pollution Control Administration, July 1968. p.145-150.

Authority for the abatement and control of pollution from agricultural sources exists within the Federal government, although it has not been used in a specific case. The basic policy of water pollution control can be found in the Water Pollution Control Act of 1948 and subsequent legislation. States are awakening to the need to provide adequate regulations concerning the disposal of animal wastes. Kansas is one of the first States in the United States to adopt regulations for the control of water pollutants from animal feedlot operations. Since many feeding operations are more than 5 miles from any city, it is unlikely that local legislation will be effective. It will be necessary to supplement and parallel any regulatory and enforcement activity with a planned educational program and a productive research program. The achievements in England, accomplished by better regulatory control and by continuing education and research, are briefly reviewed.

68-0301

Loehr, R. C. Summary and recommendations. In *Pollution implications of animal wastes—a forward oriented review*. Ada, Okla., U.S. Federal Water Pollution Control Administration, July 1968. p.151-161.

Animal wastes constitute one of six farm wastes whose management and disposal have become one of the most challenging problems of modern farming. Suitable solutions to the problem require identification and analysis of the properties of the wastes, handling procedures, treatment techniques, utilization methods, and ultimate disposal. Ultimate disposal of most of the stabilized waste material will have to be on agricultural lands. Recommendations for developmental research include studies of: the economics of waste control, handling processes and systems, treatment processes and systems, effect of the effluents and solid residues on the environment, and pollutional parameters. Recommended field research and development cover: land disposal studies, animal management studies, effects on the environment, waste and water refuse, and demonstration projects. Formal training at M.S. and Ph.D. levels, senior fellowships, workshops, and dissemination of information to the general public, the agricultural community, and personnel operating abatement systems are suggested educational measures.

68-0302

New approach to disposal of cotton crop wastes. *Agricultural Research*, 17(6):13, Nov. 1968.

An experimental machine promises to dispose of old cropstalks and roots in cottonfields by cutting the stalks and removing the roots in a single operation, separating 88 to 97 percent of the roots. The machine consists of a modified framework of a commercial trailing rotary cutter with an added standard toolbar on the rear. Best results for a cutting device attached to the toolbar were obtained with a pair of 16-in., high-lift, sweeps with trash rods extending to the rear.

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The sweeps lift the soil 3 in., and the rods give additional lift to the stubble, separating it from the soil. There was no trash buildup within the machine, which performs satisfactorily under both wet and dry field conditions, and can be operated at speeds up to 8 miles per hr.

68-0303

Pontin, R. A., and S. H. Baxter. Wastes from pig production units. *Water Pollution Control*, 67(6):632-638, 1968.

Land disposal and composting are outlined as two methods for the disposal of increasing quantities of slurry from intensive pig production units. Compared with domestic sewage, piggery wastes are two or three times as strong and possibly twice as difficult to treat by lagooning, anaerobic digestion, biological filtration, and activated sludge processes. Experiments were carried out at a piggery to determine the possible application of oxidation ditches. The final effluent from these trials contained a considerable amount of fine suspended matter which did not settle, but which could be removed by filtration. Modifications to the clarifier will facilitate pumping out settled sludge and allow the solids in the secondary ditch to be reduced. Sludge drying was not successful despite the presence of fiber in the sludge. The cost of oxidation ditch treatment is estimated to be less than that of providing dung channels and slurry storage.

68-0304

Proceedings; Second National Poultry Litter and Waste Management Seminar, College Station, Texas, Sept. 30-Oct. 1, 1968. Texas A&M University. 229 p.

The Second National Poultry Litter and Waste Management Seminar was held for the purpose of discussing possible ways of managing and disposing of poultry litter and cage manure to meet future needs of the dynamically growing poultry industry. The papers presented were: The waste disposal problem in agriculture; Mission impossible: control odors in poultry production; Environmental control—concepts and practices; Poultry litter management on Delmarva; Litter for brooding and confinement turkeys; Microbiological aspects of poultry wastes; Digesting poultry manure under cages; Nutrient recycling; Recycling poultry wastes and insecticides; The effect of reusing poultry litter on diseases and breast blisters; Trace mineral content of poultry litter and manure; Effects of poultry litter on certain horticultural crops; Dehydrating poultry wastes in Britain; and the theory and practices of anaerobic lagoon for successful waste disposal.

68-0305

Riley, C. T. A review of poultry waste disposal possibilities. *Water Pollution Control*, 67(6):627-631, 1968.

Wastes from laying hens, about 90 percent of which are housed, is a major disposal problem. This manure has higher nitrogen, phosphorus, and potassium values than any other agricultural waste, but is sticky and difficult to handle. Traditionally, this waste has been applied to the land with questions arising concerning diseases and soil fertility. During part of the year, it must be stored for periods of up to 12 weeks. Mechanical drying and heat drying of the manure has been investigated in order to utilize the waste as fertilizer or animal feed. Laboratory experiments have indicated that if caustic soda were added to the manure, the odor would

almost disappear and the number of coliforms would be reduced. The disposal of waste from deep-litter and broiler houses is not a great problem because the material is clean, easy to handle and can be disposed of on land. The inedible by-products of poultry processing stations are treated in various ways to produce fertilizer, animal feed, and fats. Processing waters can be treated successfully by the activated-sludge process.

68-0306

Riley, C. T. Wastes from the poultry industry. *Agriculture*, 75(8):374-376, Aug. 1968.

Hatchery waste, a mixture of condemned cockerel chicks, incubator fluff, and shells from hatched chicks, can be treated to produce a protein level up to 36 percent. Manure from growing stock can have a moisture content of up to 70 percent and it can have an extremely high nitrogen and valuable protein level. Investigations are underway in freeze drying to produce a fertilizer from the manure, and in recycling the manure's nitrogen to ruminants as a source of protein. The deep litter from broilers, usually a mixture of sawdust plus fecal matter, is the most easily handled and friable manure and carries the highest nitrogen content of any agricultural waste. Problems in recycling this waste to ruminants include: uncertain fiber and moisture content, and the danger of transferring pathogens. Feathers and offal from broilers give waste materials used to make protein feed, fertilizer, and other items for agriculture and industry. These wastes at present do not have a substantial return to the producer, but investigations are being made into the waste disposal disciplines to try to develop returns for the producer.

68-0307

Schmidt, G. P. Handling of animal feces from pig fattening farms. *Hygiene*, 14(12):910-914, Dec. 1968.

The feces and stable wastewater to be removed in pig-fattening farms have to be gradually processed in a manner unobjectionable in hygienic respects, as the rotting fecal wastes involve critical hygienic problems—the transmission of pathogenic germs which is made worse by flies. The relevant data published in the literature are evaluated, and the possibility of processing such feces and stable wastewaters in a manure lagoon is discussed. In addition to the manure lagoon system already operating at Wolgast, in the District of Rostock, where the wastewaters processed in the lagoons are subsequently utilized for agricultural purposes, further manure lagoons should be laid out under economically justifiable prerequisites, for they can be operated cheaply and simply. This type of manure lagoon system not only helps to utilize all organic matter but will also provide hygienically unobjectionable conditions in the pig-fattening farms. (Text in German)

68-0308

Science and improving our environment; how agricultural research prevents pollution. *Agriculture Information Bulletin* No. 319. Washington, U.S. Government Printing Office, 1967. [12 p.]

Agricultural scientists are actively fighting pollution to safeguard good health. Silt, dust, farm wastes, and pesticide

residues are all troublesome pollutants. Tons of trash are dumped illegally upon farmland in addition to the usual farm wastes. Livestock are now producing more than 2 billion tons of manure each year. A few large producers dehydrate manure, bag it, and then sell it to home gardeners and commercial growers. Others build lagoons that too often discharge fertilizer nutrients into waterways. Agricultural engineers have proposed using the fertilizer elements from manure lagoons. A series of basins, planted with grass, would serve as mechanical and chemical filters to purify the runoff water from lagoons. The forage could then be fed to livestock. Feathers, as well as dried citrus molasses and other wastes of fruits, vegetables, and crops are also used as feed. They can now be dried into a nutritious product. Research is being conducted to find new methods of controlling insects—methods that will reduce the use of chemical insecticides or lower the amounts necessary. Natural enemies of insect pests, certain viruses and bacteria, are proving effective alternates to chemical insecticides. Soil scientists are seeking ways to protect crops from radioactive fallout. An emergency standby process has been developed for washing strontium 90 off wheat.

68-0309

Soutar, D. S., and S. H. Baxter. Disposal of effluent from the piggery. *Agriculture*, 75 (4):165-170, Apr. 1968.

Handling of pig effluent in sludge form involves careful consideration of the design and management of the piggery. Sludge effluent systems can handle only limited amounts of bedding, and this factor can affect the sludge. Sludge storage requirements and methods, conveyance, dangers from the toxic gases that result from letting the sludge stand, and disposal of the sludge on land are considered. At the present state of development, properly organized field distribution of sludge as fertilizer is probably the most satisfactory answer to disposal, but this often gives rise to objectionable odors. Use of the Pasveer oxidation ditch shows promise in treating the sludge and producing acceptable effluent.

68-0310

Taiganides, E. P. Engineering properties of farm wastes. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint E-5.)

The management of animal wastes has become a national problem with the trend toward confinement production of animals. It is estimated that 90 percent of laying hens, close to 100 percent of broilers, 30 to 40 percent of swine and dairy cattle, and a continuously increasing number of beef cattle are being raised in confinement. The characteristics of the farm waste problem may be evaluated through an analysis of the phenomena associated with their generation, transport, processing, utilization, and disposal. As shown in tabular form, part of the problem is due to the nature of the wastes themselves which are not fluid enough to be pumpable by conventional pumps, nor to decompose without putrefaction, nor are they dry enough to be transportable as odor free bulk materials. Soil-plant systems offer the best potential for the utilization of animal wastes.

68-0311

Taiganides, E. P., and R. K. White. Origin, identification, concentration and control of noxious gases in animal confinement production units. Columbus, Department of Agricultural Engineering, Ohio State University, 1968. 20 p.

The conditions that generate noxious gases, what those gases might be, and how they might affect animals and under what circumstances these gases could cause death are analyzed. The principles involved in the control of odors and noxious substances are discussed. There is no scientific evidence that odors themselves affect the health of animals or humans. It is inhaling the gases, not their odor, no matter how distasteful the odor might be, that has a health significance. We must resort to analytical means for the detection of odorless gases and for the quantitative measurement of all gases. The most important gases generated within an animal confinement unit are: carbon dioxide, ammonia, hydrogen sulfide, methane, and a host of organic compounds such as organic acids, mercaptans, skatols, etc., in trace quantities. The danger is breathing air devoid of oxygen. The source of oxygen inside a confinement building is atmospheric air which is 20.1 percent oxygen. This quantity can easily be depleted in a confinement unit full of animals with no renewal of air through forced ventilation or natural drafts. Provisions should be included to have oxygen reach every spot where an animal will keep its nose for several minutes. The major noxious gases are summarized in a table. The control of noxious gases and preventive measures are enumerated. Under no circumstances should the contents of manure pits under slotted floors in farrowing houses be stirred unless the house is completely ventilated at the time of stirring.

68-0312

Thompson, P.D. Methods for disposal of poultry manure. *New Zealand Journal of Agriculture*, 116(1):44-49, Jan. 1968.

Poultry manure from laying cages should be removed at frequent intervals, and because of its high moisture content, it is not convenient to handle. Flies can be eliminated by the complete removal of the droppings every week, and by keeping the manure dry. Poultry manure has a high organic content with a good percentage of useable nitrogen, phosphorus and potash. The actual weight and volume of the droppings will depend mainly on its moisture content. One thousand laying birds will produce approximately one ton (32 cu ft) of manure a week. Poultry manure can be disposed of in three steps: the collection of droppings from the cages; the removal of the droppings from the house; and the final disposal of the manure. Various mechanized removal machines have been constructed to collect the droppings. After removing the manure from the house, the manure may be treated as fresh manure, with or without the addition of water, the prime consideration being volume. Sludge disposal is particularly effective where fresh droppings are cleaned out regularly. Indoor lagoons (under the cages) and outdoor lagoons or oxidation ponds are another method of dealing with liquid manure. Indoor lagoons rely on anaerobic and some aerobic bacteria for the breakdown of the manure, whereas in the outdoor lagoons the breakdown is mainly by aerobic bacteria. Manure drying appears to be the most promising method of dealing with the daily production of

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manure from large-scale battery units. None of the units available so far are fully automated.

68-0313

Total harvester chops stover for silage as it shells corn. *Crops and Soils*, 21(2):21, Nov. 1968.

A total corn harvesting machine, built by agricultural engineers at Iowa State University, picks and separates corn from the stalk, field shells the corn, and chops the stalk, leaves, cobs, and husk to make stover silage. The stover silage, when properly supplemented with minerals and balanced with protein, provides a cheap feed for brood cows. Crops harvested with the 'Beefmaker' machine yielded 7,100 lb per acre of shelled corn and 5,800 lb per acre of stover silage.

68-0314

Van Dam, J., and C. A. Perry. Manure management, costs and product forms. *Compost Science*, 9(2):26-27, Summer 1968.

A case study was undertaken to determine the actual cost of removing and disposing manure from a beef feedlot in Los Angeles County. Manure was prepared for marketing in three basic forms and sold under four pricing conditions. At least 6 months were allowed for manure to cure in a compost pile before processing. Product forms for marketing included: unprocessed, composted manure; processed, composted bulk; and processed, packaged compost. The combined fixed and variable costs per cu yd amounted to 10.5 cents for unprocessed, 65 cents for processed, and \$1.88 for the packaged form. The weighted average selling price per cu yd was \$3.80 for packaged; \$2.40 for processed; \$1.40 for unprocessed, and \$1.00 at the stockpile for unprocessed manure. The processed bulk product had the greatest net revenue based on net returns, product form volumes, and weighted average price, less total costs. It was concluded that a livestock feedlot operator could realize a profit from the sale of manure.

68-0315

Wasteigh, C. H. Wastes in relation to agriculture and forestry. U.S. Department of Agriculture Miscellaneous Publication No. 1065. Washington, Mar. 1968. 112 p.

The situation regarding wastes in relation to agriculture and forestry is very thoroughly treated with literature references to specific points cited. Areas covered are: wastes as they affect the agriculture and forestry industries; wastes contributed by the agriculture and forestry industries; research, ongoing or completed, by the U.S. Department of Agriculture and State agricultural experiment stations contributing to the amelioration of waste problems; and problems in waste management requiring attention in agriculture and forestry. Ten major categories of materials which contaminate the environment in relation to agriculture and forestry are: radioactive substances, chemical air pollutants, airborne dust, sediments, plant nutrients, inorganic salts and minerals, organic wastes, infectious agents and allergens, agricultural and industrial chemicals, and heat.

68-0316

Waste problems of agriculture and forestry. *Environmental Science and Technology*, 2(7): 498-503, July 1968.

Because it has become more economical to build soil nutrient levels by applying synthetic fertilizer from a bag rather than

using animal manure, a waste disposal problem has developed. Removing the waste from animal quarters and spreading it on land represents a significant cost to the meat producer. Suburbanites moving into agricultural areas have protested against accumulations that give off malodors. A report from the Department of Agriculture lists goals of identifying and destroying odor-producing bacteria prevalent in manures, treating manure to eliminate flies and vermin, and developing better procedures for applying manure to cropland. Controlled burning is the only economically feasible technique for disposing of forest trash (an average of 25 million tons per year). However, this produces air pollution. The total contribution of processing wastes (agricultural, meat, etc.) to water, air, and land contamination is tremendous. The amount of processing wastes can be lessened by the development of useful products, the improvement of processes so that less waste is produced, and the development of ways of treating wastes before disposal in streams. There is need for widespread control of plant disease agents and allergens. Other environmental contaminants in relation to agriculture and forestry are: radioactive substances, chemical air pollutants, airborne dusts, sediment, plant nutrients, inorganic salts and minerals, organic wastes, agricultural and industrial chemicals, heat, etc.

68-0317

White, R. K. Analysis of volatile gases from animal wastes using gas chromatography. A review and abstracts of selected references. *Agricultural Pollution Control Research Laboratory Report No. 16*. Columbus, Ohio State University, 1968. 16 p.

A review and abstracts of selected references on the analysis of volatile gases from animal wastes is presented. In order to determine the conditions under which the offensive odors from animal wastes are generated, the volatile compounds must be separated, identified as odorous or non-odorous, identified qualitatively, and evaluated quantitatively. Sampling and collecting techniques basically use a cold trap of dry ice in acetone and/or a cold trap of liquid nitrogen. Sensory identification of odorous components includes the use of a stream-splitter on the effluent from a gas chromatograph. Qualitative identification of odorous components can use retention time, peak enhancement or elimination, selective chemical absorption of effluent peaks, and mass and infrared spectral techniques. Quantitative analysis of odorous components is associated with peak height or area. An internal standard method of quantitative analysis is discussed.

68-0318

Witzel, S. A. The nitrogen cycle in surface and subsurface waters. Madison, University of Wisconsin Water Resources Center, Dec. 1968. 65 p.

The objectives of the nitrogen cycle studies are: to determine sources of nitrogen and phosphorus which are contributing factors to lake eutrophication; to determine what contributions originate from farm animal wastes and other farming operations; to determine what effect season of application, frost conditions, and snow cover have; to study losses of N and P to subsurface water as the rate of application of animal wastes is varied; to study plant recovery of N fertilizers; and to study action of microorganisms in the

steps of the nitrogen cycle. Plots receiving no manure and from which plant residues have been removed had more surface runoff and produced lower yields when compared with those which receive manure incorporation into the soil. Ground water, which supplies the base flow in streams, probably contributes less than 20 percent of the total nutrients in the streams. In pervious soils under high fertilizer applications, considerable leaching of N to ground water was found. On shallow, moderately permeable soils in one studied area, many of the farm wells produce water already exceeding the safe level of nitrates. The evidence clearly indicates that N added to the soil, in the form of commercial fertilizer or as manure in excess of crop needs, may result in considerable movement of nitrate N to ground water. Microorganisms capable of rapid nitrification have been found. Reports of toxic levels of both nitrate and nitrite are serious enough to call for an intensive program of research. Phosphorus is lost through runoff when it flows over or comes from exposed animal wastes on frozen ground or feedlots.

68-0319

Witzel, S. A. Ground water pollution in the Rib Falls Community, Marathon County. In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968. p.10-13.

The geology of this part of the north central area of Wisconsin is such that high amounts of nitrates are expected to show up in the ground water as a sensitive indicator of dangers from current practices of waste disposal and fertilizer applications. Many wells are shallow, improperly constructed, poorly located, and are influenced by excessive applications of animal manure, as much as 60 tons to the acre around farm building areas. When the nitrate radical content of the domestic water supply on a dairy farm was found to be 158 mg per liter, the farmer was advised to bring in safe water for drinking and cooking. Continuing studies on this and other wells in the area have shown a high nitrate concentration in the wells, that is, containing more than 45 ppm of nitrates. Shallow wells and drilled wells less than 100 ft in depth were apt to contain high nitrite contents in relation to nitrates. Shallow wells obviously collecting drainage from feedlots, manure pits, silo drainage, and similar sources were high in nitrates and in bacterial counts, namely total bacteria, total coliform, and even fecal coliform counts. The leaching of soluble nitrates is apt to occur during periods of heavy rainfall in this area, particularly in late fall and early spring. The process is accelerated when the soil is not frozen, and no vegetation is growing to remove both nitrate and moisture from the soil.

68-0320

Witzel, S. A. Migration of nitrates in soils as bearing upon the problem of nitrates in subsurface waters. In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968. p.14-23.

Nutrient losses due to percolation were determined by using soil profile samples taken at various levels through and below the root zone. The samples were analyzed for ammonia radical, nitrite radical, nitrate radical, and total organic nitrogen. The chemical analyses were made on water, soil, plant tissues and waste with the Bremner-Keeney apparatus.

The effect of soil type, soil management, cropping practices and land use on farms, and amounts and movement of nitrogen through the soil profile were studied. Results completed to date include three sets of profile samples of cropped and virgin soils taken at three experimental farms. Data show that total recovery of fertilizer nitrogen by the crop as soil nitrogen ranged from 48 to 64 percent, and that recovery under fallow conditions was 99 percent. Results obtained on the movement of nitrogen through the soil profile suggest that the sampling of soil profiles will provide much needed information on the forms and amounts of nitrogen present, their rate of movement, their relation to manure and fertilizer practices, and the extent of pollution of underground water. A comparison between the profiles of virgin and cropped soils will give a good idea of the extent to which the rate of pollution of underground water with nitrate has changed since the land was first placed under cultivation. Studies are being continued on nitrogen movement through soil profile in relation to manure and nitrogen applications, barnyards, feeding lots, soil type, topography, various cropping practices, and virgin conditions.

68-0321

Witzel, S. A. Ecological relations of pollutional bacteria percolating in fertile agricultural soils. In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968. p.24-25.

The first experiments on movement of pollution bacteria through soil were done on a laboratory scale with soil columns set up on the lysimeter principle. Water was first passed through to equilibrate to about field capacity moisture. In a silt loam soil, the coliform bacteria with starting counts of 10 million per ml of water were trapped in the first 8 in. of soil in the columns. In sand, they passed through 2 ft and still showed over 100,000 ml in the water collected. In a field experiment, 5-gal metal pails (with bottoms cut off) were set to about three-quarters of their depth into a field of Miami silt loam. One set of three pails received a manure-water slurry in amounts to represent 15 tons per acre; a second set, 80 tons per acre; a third, 15 tons per acre, followed a week later by an additional 15 tons per acre application; and a fourth set, untreated controls. Counts of both coliform and enterococci in the manure slurry were determined to be approximately 10 million and 100 million per ml, respectively. Differential counts showed both types of pollution bacteria to be removed by adsorption within the first 14 in. of soil.

68-0322

Witzel, S. A. Effects of agricultural practices on ground water quality. In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968. p.26-36.

The effect of nitrogen fertilizer, applied at high rates on growing irrigated crops, on the quality of ground water was investigated. The light sandy soils of central Wisconsin were selected for the study, and a total of 17 well points were driven to full screen depth (4 ft) below static water table, on the periphery, and at critical points within a sequence of eight fields. The rainfall for the study period totaled 16.39 in., and irrigation was applied to certain fields. Results indicated that fertilizers do contribute to the nitrate

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concentrations in the ground water in this area, therefore shallow wells would not always provide a safe water supply. Water from one test well was above the toxic level of 10 mg per liter of nitrate N nearly 50 percent of the year. There may be a buildup of nitrates in the aquifer to increasingly greater depths with continued application of fertilizer and the conversion of more of the land to intensive crop production. The irrigation well is deep into the aquifer, and it is picking up high nitrate concentrations in the draw-down cone.

68-0323

Witzel, S. A. Biological nitrification—is it a source of the nitrite or nitrate in surface and subsurface waters? In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968. p.39-42.

A survey of *Aspergillus* and *Penicillium* species for their nitrifying ability, and tests of selected soil and water samples as to relative activity of their autotrophic and heterotrophic nitrifying populations were carried out. Nitrifying species were found in all groups of *Aspergillus*. Of the 24 species of *Penicillium*, none produced nitrate in Schmidt's Medium, while 21 of the 24 did when 0.5 g per liter of sodium nitrite was added. In general, it was found that the tested active nitrifying cultures contained many actinomycetes and gram-bacteria. Of 47 cultures tested for heterotrophic nitrification, 45 produced nitrite-nitrogen in the range 5 to 154 per micro g per ml; the average was 48.8 micro g per ml. Because the heterotrophs concerned are common and widely distributed, they must be considered in ecosystems where nitrification occurs. Experiments with nitrification in water slurries of poultry manure have been carried out, and some very active heterotrophic nitrifiers, mainly actinomycetes, have been found. Literature on feedlot runoff shows very high production of nitrates under conditions in which autotrophic nitrification is highly unlikely. It was concluded that biological nitrification is certainly one source of the problem levels of nitrate and nitrite in water.

68-0324

Witzel, S. A. Plant nutrients in base flow of Southwestern Wisconsin streams. In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968. p.43-46.

A study of the base flow on 38 water sheds from 2.2 to 88 sq. miles in size and confined to unglaciated, deeply undulated southwestern Wisconsin terrain was undertaken to obtain a measure of the degree of pollution prevailing in the streams during base flow. At that time, they represent ground water, plus any added effluent from sewage plants, milk and cheese factory wastes, or feedlot drainage. Biweekly samples were taken and analyzed for N, P, and K. The 1967 data showed an unusual and unexplained high level of organic nitrogen for some streams on May 23. These were deleted in computing the average for 1967. The high levels may have been caused by some unusual local conditions such as whey discharge from cheese factories, cattle standing in the stream, or other occurrences. The small amount of nitrogen compounds in these streams was equal to about 10 percent of the nitrogen received annually through precipitation. The vegetation on these lands was recovering much of the

nitrogen from agricultural wastes, fertilizers, legumes and precipitation, except for losses in surface runoff, the volatilization of ammonia, and denitrification with gaseous nitrogen being lost to the atmosphere. While representing only a small part of the total base flow, the contributions of sewage plant effluent from rural villages, cheese factories, and from some poorly located barnlots, may have supplied most of the P and K. By diverting raw wastes to land disposal and treated wastes to tertiary treatment, more of the P and K could be removed from this base flow.

68-0325

Witzel, S. A. The Lancaster plots. In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968. p.47-49.

Present-day practices still include the daily or periodic hauling of animal wastes to fields throughout the winter. The nearly level fields have been favored with higher waste applications. A set of eight small plots, 10 by 40 ft in area, were established for the purpose of obtaining nutrient losses through runoff under controlled conditions. The treatments on these plots were set up to determine the effect of animal waste applied on the land and the conditions under which it is applied on the amount of nutrient losses. The plots were equipped for runoff retention and sampling in all seasons. The treatments were made with dairy cow feces and urine applied at the rate of 15 tons per acre. Corn was grown on all plots, received starter fertilizer in the row, and was harvested for silage. The 1967 results represent the most adverse conditions possible; these were accompanied by high nutrient losses. A three-quarter in. rainfall occurred only 2 hr after the manure had been applied on frozen ground without snow cover. The three-quarter in. runoff from this rain contained 17 percent of the N and 6 percent of the total P that was present in the freshly applied manure. After subtracting the nutrient losses in the control plot runoff from those in the runoff from the plots receiving manure applied on frozen ground, two plots were found to have lost 19.8 percent of the N, 11.3 percent of the soluble P, and 12.2 percent of the total P contained in the waste application.

68-0326

Witzel, S. A. Quantifying nutrients from an agricultural watershed. In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968. p.50-56.

A 12-month study was made of the nutrient losses from a 6.5-mile watershed. While the soil is generally considered to be quite adequately drained most of the time, the waterways are not fully developed, and as a result a considerable amount of runoff tends to accumulate in depressions to form ponds during snow melt and in rainy seasons. The agriculture in the area is largely dairying, with pasture, and the farm crops are corn, oats, and alfalfa. Seven determinations were made on each sample: total organic nitrogen, ammonia, nitrogen dioxide, nitrogen trioxide, Ortho P, total P, and soluble K. Nutrient losses during runoff were from 72 to 80 percent of the total yearly losses except for nitrate which was about 58 percent of the total. Extensive winter spreading of manure on the fields in a year of average snow cover may have a greater effect on the amount of losses in a normal year. For the year under study it could be concluded that about 75 percent of

the nutrient losses were in the periods of runoff from the land, and about 25 percent were in the base flow. The monthly nutrient losses peaked during the high flow months. While this was not a normal year for snow melt and the usual heavy winter or early spring runoff, the effect of winter manure spreading on frozen lands did show up. Over 20 percent of the annual nutrient losses resulted from 10 percent of the annual runoff in February, while only 10 percent of the losses came from 18 percent of the runoff in April.

68-0327

Witzel, S. A. Fennimore Watersheds 1967 runoff and nutrient losses. In *The nitrogen cycle in surface and subsurface waters*. Madison, University of Wisconsin Water Resources Center, Dec. 1968, p. 57-59.

Four small watersheds located near Fennimore, Wisconsin, were selected for a study of nutrients in the runoff from strictly agricultural land. A water sampler was developed for the collection of samples at predetermined increments of rise and fall in the stages of the flow over the weir. A record of the amount of manure, pasture days for cattle, and mineral fertilizer applications provided information of N, P, and K applications to the land. There were two periods of runoff during the 12-month period: the first, accounting for approximately 75 percent of the total losses of N, P, and K occurring from one in. of rain and snow melt on January 24, 1967; and the second following 0.6 in. of rain on March 23 and 24, followed by snow melt during the last week of the month. The relatively high percent of nutrients lost on a pastured area, which received no winter manure, is probably due to cattle leaving a large amount of their droppings in the ponded area immediately above the weir. On the basis of 1967 data, a year when nearly all surface runoff resulted from rain on frozen ground and melting snow, there is little evidence to support the claim that winter application of manure is a serious stream pollution hazard. The nutrients lost in surface runoff, however, were about five times those in the base flow of southwestern Wisconsin streams.

68-0328

Witzel, S. A., L. B. Polkowski, E. McCoy, et al. Farm animal waste disposal research at the University of Wisconsin. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, H. Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint E-2.)

Major sources of pollution and nutrient losses are being studied in relation to: runoff from paved barnyards; stacked, piled or dumped manure; and manure applied to frozen ground. Anaerobic tank storage of liquid manure is proving to be most effective in preserving plant nutrients. An experimental lagoon was found to contain a bacterial population for waste reduction comparable to the soil's, which can break down substances, except lignin, quite rapidly. Test plots have been used to determine the recovery of nitrogen fertilizer in the crop, the amount remaining in the soil, and the movement of residual nitrogen through the soil profile. A field problem is being investigated in an area with a confined aquifer in a prosperous Wisconsin community where the zone of pollution of the groundwater now extends to the bottom of the water resource, and nitrates have been found in the range of 30 to 100 ppm. The results of research are being used to solve pollution problems on the farm and to inform farmers of potential hazards of pollution.

68-0329

Wymore, A. H., and J. E. White. Treatment of slaughterhouse waste using anaerobic and aerated lagoons. *Water and Sewage Works*, 115 (10): 492-498, Oct. 1968.

A treatment plant for wastes from a hog slaughterhouse, consisting of a lagoon system utilizing both anaerobic and aerated lagoons, was suggested, since existing facilities (an extended aeration plant and a 4-acre polishing lagoon) were greatly overloaded. Design criteria were determined from a 24-hr survey of the plant, which had a designed kill rate of 3,800 hogs per day. The effluent data, design criteria, lagoon system design, and an analysis of the air flotation tank influent of the old waste treatment plant are tabulated. Laboratory analysis of the various effluents, evaluations of the various parts of the system, and average unit removals in percentages are also tabulated. The entire system removes 99 percent of unfiltered BOD and 98.6 percent of the suspended solids.

AUTOMOBILE

68-0330

Alpiser, F. M. Air pollution from disposal of junk autos. Presented at 61st Annual Meeting of the Air Pollution Control Association, St. Paul, Minn., June 23-27, 1968. Durham, N.C.: National Air Pollution Control Administration, June 1968. 19 p.

Restrictions on open burning have forced experienced scrap dealers to rely more and more on the use of fragmentizers because the visible emissions from these processes are usually less than a No. 1 Ringelmann. The fragmentizer offers a partial solution to the disposal problem for large metropolitan areas, but domestic pressures for high quality and lower price scrap may seriously affect process economics if foreign sales are reduced. A medium or small metropolitan area may benefit from the installation of a medium or small auto shredder or macerator. Careful consideration of the scrap market and the availability of junk autos is necessary before investing in a fragmentizer or shredder. Two of the most promising new processes for auto disposal are the pyrometallurgical purification of chopped auto scrap and a process which combines low grade, nonmagnetic taconite ore with the scrap to increase iron content. The effectiveness of air pollution control equipment for these processes has not yet been determined.

68-0331

Andrews, J. B. Operation junklift—a community public works program. *Public Works*, 99(4): 96-98, Apr. 1968.

The location and legal release of junked automobiles in Portland, Maine, was carried out by volunteers from the Neighbor Center and Neighborhood Youth Corps enrollees. The city's contribution to the removal phase was two dump trucks and one small crane. Service organizations secured donations of flatbed trailers, additional cranes, and volunteer manpower. Over 400 cars were removed and deposited at a designated staging area. A contractor crushed the vehicles in a machine powered by a Ford V-8 engine, and trucked them to a company in Everett, Massachusetts, where they were shredded and eventually reprocessed to high-grade steel.

Automobile

68-0332

The automated carbeque comes to Britain. *Materials Reclamation Weekly*, 11(24):23, June 15, 1968.

A Japanese franchise for the supply and installation of an automated plant for the disposal of old motor cars has been granted to Motherwell Bridge Tadol Ltd. Known as the Carbeque, this barbeque for cars can handle one car every 6 minutes, producing clean, fired steel scrap by disposing of all cellulose, plastics, wood, leather and nonferrous components. It consists of an oil-burning, high combustion chamber capable of taking three cars at a time, and a rotary chucking unit consisting of two hydraulically operated rams which revolves the cars so that molten nonferrous material falls clear. Car bodies less engine, gearbox and back axle assemblies are loaded on trolleys and moved into the combustion chamber. The trolley is tilted so that the vehicle shell falls into a high-powered press and then passes to a baling machine. The bale is guillotined to a suitable size and loaded by conveyor. Equipment may be added to reclaim the nonferrous metal although the limited amount produced is hardly worth separating. The carbeque is provided with grit, dust and fume handling equipment in compliance with the requirements of the Clean Air Act. Three of these automated plants are in operation in Japan and another is being constructed in Chicago. (Also appears in 'Car Crusher from Japan', *Surveyor and Municipal Eng.*, 131(3968):51, June 22, 1968).

68-0333

Bird, A. P., and F. J. A. Shults. Scrap car disposal: a joint session. *Public Cleansing*, 58(8):432-443, Aug. 1968.

Car crushing and fragmentation is being used in London for the disposal of abandoned automobiles. The autos are first stripped of tires, engines, gas tanks, and radiators, and are then delivered to the car crusher. The concept of planned obsolescence has produced an increasing number of abandoned automobiles. The treatment of this scrap has become sophisticated to a high degree. Approximately 40,000 cars per year and ten assembly sites are involved in the operation. The laws governing the removal of the autos are considered, and the necessity for the individual boroughs to procure a reliable contractor to remove cars and to spell out the terms of the contract in detail is stressed.

68-0334

Brown, R. R., and F. F. Block. Copper removal from steel scrap by thermal treatment. U.S. Bureau of Mines Report of Investigations No. 7218. Washington, U.S. Department of the Interior, Dec. 1968. 15 p.

To determine the practicality of removing copper from automobile scrap by thermal treatment, several laboratory scale experiments were tried. Test specimens, produced by wrapping bare and insulated copper wire around small steel coupons, were heated at 600 to 1,150 °C in various atmospheres for differing periods of time under both static and dynamic conditions. The test procedures and data are detailed. The test indicated that adequate removal of copper cannot be effected by thermal treatment above the melting point of copper. The copper present in scrap as insulated wire is embrittled by thermal treatment at 800 to 900 °C if the

contains lead, and the embrittled copper is almost completely removed by mechanical action such as tumbling. Chemical pretreatment of specimens to cause embrittlement of copper and the magnetic separation of oxide scale were also studied. Tests showed that bare copper can be embrittled by depositing waterglass (sodium silicate) with thermal treatment.

68-0335

Cars and dumps. *Public Cleansing*, 58(4):186-190, Apr. 1968.

At a meeting of the Midland Centre at Newcastle-under-Lyme on February 23, 1968, part three of the Civic Amenities Act, 1967, was discussed. The object of the act is to place a duty on local authorities to ensure that adequate facilities are available for the orderly disposal of disused vehicles, equipment, and other rubbish, and to provide these authorities with power to take action against people who do not take advantage of the facilities. In some cases, the owner of a vehicle is located and a notice is sent telling him where the vehicle is, and requiring him to remove it within 21 days. Authorities may charge owners, when located, for the removal from highways, storing, and disposing of vehicles. Publicity, informing the public of places where refuse would be accepted and pointing out the penalties involved should be given through local public newspapers. It was suggested that disposal plants for scrap be run in conjunction with iron and steel works.

68-0336

Dean, K. C., R. D. Groves, and S. L. May. Copper cementation using automobile scrap in a rotating drum. U.S. Bureau of Mines Report of Investigations No. 7182. Washington, U.S. Department of the Interior, Sept. 1968. 12 p.

The comparative merits of using shredded automobile scrap in a rotating drum and shredded tinplate in launders for copper cementation were assessed. The materials, equipment, and procedures used are described, and the results compared as to efficiency and cost of operations. The tests established that the scrap in the rotary drum precipitated copper faster and more completely than shredded, detinned, tinplate scrap in a launder, and with comparable iron consumption also. Although power is required to rotate the drum, the faster precipitation and continuous recovery of cement copper are advantages of the tumbler method. Cost evaluation indicates that the rotary drum method, which uses relatively low-cost, and readily available shredded automobile scrap, is competitive with the launder method which uses relatively high-cost shredded tinplate scrap or detinned shredded cans.

68-0337

Discriminatory railroad freight rates constitute a barrier to solving the city's junk car problem. *Waste Trade Journal*, 64(29):3, July 27, 1968.

The increasing problem of auto salvage is discussed. Until recently, obsolescent iron and steel flowed in a natural cycle from user to scrap processor. This natural cycle has slowed down because of the inability of scrap processors to transform items economically into usable scrap for

steelmaking. This has occurred because increased freight rates have been imposed on the iron and steel scrap industry by the railroads. There is a backlog of junked autos because these freight rate increases can neither be absorbed by the processor nor passed on to the consumer. In February, 1968, the ICC ruled that iron and steel scrap and iron ore were directly competitive and limited the increase in scrap rates to the same 10 cents per ton maximum allowed for iron ore.

68-0338

Economical car salvage. *Science News*, 93(8):181, Feb. 24, 1968.

A continuous operation for melting iron from old cars was patented (U.S. Patent 3,367,769) by Clarence C. Schott of Baltimore, Maryland. In the process, two cars are squeezed together, then loaded into a furnace stack with a fuel-oil fire at the bottom. The iron is melted in the furnace, which burns with a short supply of air to minimize oxidation of the metal. The partially-burned gases from the furnace are exposed to enough air further up the stack to burn them completely. Heat from this combustion burns any nonmetallic components in cars further up the line.

68-0339

Eiger, G. W., W. L. Hunter, and C. E. Armantrout. Removal of nonferrous metals from synthetic automobile scrap on heating in a rotary kiln. U.S. Bureau of Mines Report of Investigations No. 7210, Washington, U.S. Department of the Interior, Dec. 1968. 17 p.

Four tests with synthetic scrap mixtures heated at various temperatures under oxidizing and reducing conditions were conducted to determine the feasibility of removing nonferrous metal impurities from automobile scrap by thermal treatment in a rotary kiln. The treated scrap mixtures were melted in an electric arc furnace and cast into small ingots for impurity evaluation. Analyses showed that the ingots were all essentially free from residual metal impurities except copper. Data indicated that in an oxidizing atmosphere, the percentage of copper removed increased with treatment temperature, while a reducing atmosphere was found not to be temperature dependent. Copper was embrittled under some of the operating conditions and was mechanically removed by fragmentation. The details of each testing procedure are given along with copious data and illustrations.

68-0340

Goddard, I. Illinois auto salvage waste pollution control. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. H-3.)

The problems of automobile salvage in Illinois revolve around the reuse of scrap in the steel manufacturing process. At present, steel mills do not use sufficient amounts of scrap at a break-even economic level to induce dealers to move scrap in an orderly flow. There are three fragmentation types of installations in Illinois, one which costs \$3 million, and the other two which involve investments of \$1 million each. This type investment can only be justified in centers of dense population where water transportation, as well as good rail

and highway networks, are available. It has been established that an auto salvage dealer cannot economically haul vehicle hulks more than 35 miles to a scrap processor. Since open burning is prohibited in Illinois, many junked hulks are accumulating. The inclusion of a \$30 disposal fee in the purchase price of each new car is suggested.

68-0341

Automobile blight—where we stand. Augusta, Maine, Keep Maine Scenic Division, State Park Recreation Commission, [1968]. 19p.

The Keep Maine Scenic Committee has searched for solutions to the problem of junked cars, and is attempting to serve as a clearing house for information on this subject. A brief background history of junk car disposal is given, and trends in vehicle scrapage are tabulated. Consideration of soil conditions is recommended before attempting to bury cars in pits as part of a cleanup campaign. The three Maine statutes covering automobile blight (anti-litter, miscellaneous nuisance, and junkyard and auto graveyards) are included, as well as the regulations for screening junkyards, and the general statutes of Connecticut and Rhode Island concerning abandoned vehicles. Maine State Police have conducted junkyard enforcement programs resulting in approximately 1,500 investigations and fines as high as \$500. Portland's operation junklift is described in detail. Many junked cars have been shipped from Maine to Everett, Massachusetts where a Proter plant with a capacity of over 1,000 cars per day shreds automobile bodies. It is suggested that a burial fee be imposed on all new vehicles; scrap dealers be made eligible for state guaranteed loans for equipment; and landscape assistance be provided for junkyard operators.

68-0342

Makar, H. V., B. W. Dunning, Jr., and H. S. Caldwell, Jr. Laboratory studies on the use of sodium sulfate for removing copper from molten iron. U.S. Bureau of Mines Report of Investigations No. 7199, [Washington], U.S. Department of the Interior, Nov. 1968. 14 p.

Tests were performed to obtain a quantitative description of the effectiveness of sodium sulfate for removing copper from molten iron and to determine the effectiveness of sodium sulfate on actual auto scrap. The tests were conducted on induction melted heats of iron averaging 0.58 and 1.50 percent initial copper. The sodium sulfate was added in powder form in amounts ranging from 2.9 to 43.8 percent of the weight of iron being treated. The data showed that copper removal for the various sodium sulfate treatments followed a similar trend, regardless of the iron composition that was tested. Copper removals ranged from 3.3 to 74.5 percent down to less than 0.10 percent. Copper removals were generally accompanied by sulfur removal, and the initial sulfur contents, ranging from 0.10 to 0.20 percent, were reduced to as low as 0.02 percent. High temperatures and long slag reaction times tended to induce copper and sulfur reversion from the slag, but, generally, the sodium sulfate treatments were effective up to approximately 2,820 F with reaction times not exceeding 7 minutes.

Automobile

68-0343

Nashville firm to install Southeast's 1st auto shredding plant; cut air pollution problems. *Waste Trade Journal*, 64(14):1, 4, Apr. 13, 1968.

The Steiner-Liff shredding power plant of Nashville, Tennessee, generates 2,000 hp and is capable of surging to 5,000 hp 3 times per minute. Devices for the control of air pollution include a furnace chamber afterburner and two magnetic separator systems for removing pure steel from nonferrous materials. The shredding plant will incorporate "throw-away" hammers that can be changed weekly without the need for additional labor expense. The plant is designed to produce 600,000 lb per day of pure scrap steel. Total time for destruction of an automobile is 60 seconds.

68-0344

New ideas for tackling old cars. *Materials Reclamation Weekly*, 113(19):196-197, Nov. 9, 1968.

A 500-ton capacity Hydra-Shear is claimed to operate on a principle new to the scrap industry. The process involves a three-step system consisting of an hydraulically powered shear, a 700 hp condenser, and a magnetic separator to remove nonmetallics and nonferrous metals. A series of conveyors link the various components. The condenser unit produces fist-size, nugget-shaped pieces of steel, with a density from 80 to 120 lb per cu ft. The machine will produce from 8 to 15 tons per hr. An explosion suppression system crushes a car to scrap nuggets in about 30 seconds. Safety detectors prevent dust arising from the scrapping process from exploding. Other ideas include a hydrometallurgical process that turns steel scrap into high-purity iron powder. Shredded car scrap in a rotary drum device will precipitate copper from acidic sulfate solutions faster and more completely than will shredded, detinned, tinplate scrap in a gravity launder. Besides speeding the reaction time and giving a cleaner copper product, the car scrap rotary drum method precipitates and removes copper in a continuous process and allows the use of an often objectionable solid waste.

68-0345

Ogden, M. Engine-powered shredder for car body disposal. *Diesel and Gas Turbine Progress*, 34(7):35, July 1968.

A Phoenix, Arizona, company is processing discarded car bodies, tin cans, metal stampings, and other scrap metal and selling the fragments to copper smelters and steel mills. A Waukesha L7040G natural gas engine provides the power for the metal fragmentizer. The engine is equipped with four Vortex oil bath air cleaners. A product called "slabs," created with an electrically driven hydraulic press, is sold to steel mills. Car bodies go into the ripper—a Mosely Automatic Strippy—located alongside the engine shed. Cans and stampings bypass the ripper unit. All metal goes into a specially designed hammermill where chunks are reduced to approximately 8 in. Nonferrous metals are placed on a trash belt, and paint and waste materials are removed by burning in a gas-fired rotary kiln. Further magnetic separation follows.

68-0346

Open burning of old autos. *Waste Trade Journal*, 64(9):26, Feb. 29, 1968.

The president of the National Federation of Independent Scrap Yard Dealers told the Subcommittee on Air and Water Pollution, of the Senate Public Works Committee that before instituting regulations against open burning of automobiles, alternative methods should be presented. Possible alternatives are: hand stripping; controlled incineration through chamber type and small batch-type incinerators; and fragmentizing or shredding.

68-0347

Oren, O. H. Artificial reefs; a short review and appeal. *FAO Fisheries Circular* FR/C305. Rome, Italy, Food & Agriculture Organization of the United Nations, Dec. 1968. 6 p.

In the last 10 years, the Government of Japan, after recognizing the importance of artificial reefs and fish apartments, has invested millions of dollars in this method of improving the marine habitat. One type is the "gyosho", an artificial reef, constructed from junk, trees, broken boats filled with waste and all kinds of solid and semisolid trash. More recently, hollow concrete blocks were used. In Italy efforts are being made to convince industry to begin experimenting with artificial reefs using scrap cars. There have also been some developments in establishing artificial reefs in Israel. The planned dumping of old motor cars, railway cars, tractors, agricultural machinery, etc., would improve the countryside, provide a common solution to disposal problems as well as create artificial reefs in large bodies of fresh water. A list of references is included.

68-0348

Ralph Stone and Company, Inc. Copper control in vehicular scrap with special emphasis on component design. Los Angeles, Mar. 1968. 109 p.

A study was made of copper-containing vehicular components for the U.S. Department of the Interior, Bureau of Mines, Solid Wastes Program, Contract 14-09-0070-382. Some components and hulk samples of recent (1957 and 1967) domestic and imported automotive models and other trucks (1950 and 1953) were analyzed for copper content at the Stone Company's laboratory. The copper-containing components, their location, and attachments were identified. Time-motion field studies were applied to a representative cross section of salvage and scrap processing yards to establish prevailing component-removal techniques, times, equipment, and related costs. Recent innovations in scrap processing equipment and methodology were studied in relationship to scrap quality, productive efficiency, and economic feasibility. A major effort was to recommend improved vehicular design for the purposes of reducing copper content and facilitating the removal of copper-containing components. Numerous supporting data and illustrations are appended.

68-0349

Ralph Stone and Company, Inc. Summary. In Copper control in vehicular scrap with special emphasis on component design. Los Angeles, Mar. 1968, p.1-6.

The principal deterrent which restricts wider acceptance of purchased automotive scrap in steelmaking today is the contamination of scrap steel by residual elements such as copper, nickel, zinc, chromium, lead, molybdenum, and other nonferrous metals. Of these contaminating elements, copper is by far the most significant because it is present in the largest quantity and creates undesirable characteristics in the finished steel. The technical-economic factors involved in removing the copper components, the development of recommendations and conclusions for improving automotive steel scrap quality through better automotive design, and the control of copper components are investigated. Quality sheared automotive slab is a relatively recent innovation in the scrapping industry. The central piece of operating equipment is a combination bales-shearer. This unit first compresses the automotive hulk into a rectangle about 2 by 2 by 20 ft in length. The scrap log is fed into a guillotine shear which cuts it into predetermined lengths. The quality of the sheared scrap, as with the No. 2 bundle, depends on the thoroughness of the stripping operation preceding the bales-shear operation. Trained crews remove not only all copper components, but also all zinc, chrome, stainless steel, and nonmetallic contamination. The total time required is 40 to 60 man-minutes per ton of product.

68-0350

Reichmayr, J. High intensity fuel burner for steel scrap melting. Blast Furnace and Steel Plant, 56(11):1,003-1,006, Nov. 1968.

The prevailing large quantities of automobile scrap make the use of scrap important. Various factors appropriate to the reuse of scrap are considered as they affect the melting and reuse cycle. Oxidation of the metal and heat loss are two problems. For scrap melting, higher firing rates of more than 200 million Btu per hr will be required prior to reaching economical production rates. The high intensity burner with oil atomization, called the toroidal burner, provides this. The design and operation of the burner are considered, and illustrations are given. These new high intensity fuel burners are causing changes and may keep the open hearth furnace competitive with the Basic Oxygen Furnace as long as there are excessive amounts of scrap to be cleaned up.

68-0351

Reid, L. C. A study of scrap disposal in the Fairbanks-North Star Borough, Alaska. College, Alaska, U.S. Department of Health, Education, and Welfare, Apr. 1968, 42 p.

The scrap disposal problem and several alternative solutions are explored. Physical inventories and personal interviews were used to estimate the amount of scrap in the area. A set of mathematical models was devised to determine the replacement rate for automobiles. Results showed that once the backlog of automobiles has been processed, there would be an average of 2,700 vehicles per year available for scrap.

The potential industrial scrap consists of outdated construction and heavy mining equipment, assorted boilers, etc. Automobiles and light scrap may be prepared for shipment by burning and baling, flattening, or shredding. Alternatives to the accumulated scrap problem are: do nothing; collect and store autos in a central location; bury autos in a central location; ship to Seattle; prepare scrap and smelt in an electric furnace; use the autos for floor control structures; or prepare scrap locally and sell by type in Japan. It is recommended that scrap be prepared locally and sold by type in Seattle. To accomplish this, the Fairbanks-North Star Borough should petition the general manager of the Alaska Railroad for an emergency rate reduction to \$10.75 per ton for a one-year period. Also, it is recommended that a tax of \$1.50 per motor vehicle per year should be levied on all cars registered in the Fairbanks-North Star Borough area to help finance scrap dealers.

68-0352

Taking the danger out of breaking up old cars. Public Cleansing, 58(10):511-512, Oct. 1968.

The safe handling of gasoline tanks has caused concern in the auto-wrecking field. A new aerosol discharges a mixture of nonflammable gas and liquid into the tank, rendering it completely safe. The contents of the aerosol consists of a mixture of a chlorinated solvent and an aerosol propellant which is a chlorinated fluorinated hydrocarbon. The produce renders the tank safe for a long period after treatment, even if a residue of gasoline has not been drained off.

68-0353

Test held on the burning of junk cars. Waste Trade Journal, 64(51):6, Dec. 28, 1968.

State officials joined with representatives of the Nebraska New and Used Auto Parts Assn. to observe the burning of two junk cars in a demonstration to determine the most feasible means of vehicle disposal with a minimum of contamination to the atmosphere. The gas tank and tires were removed from the first car, and its windows were smashed, while it remained in an upright position. After fuel oil that had been poured over the car's seat was ignited, the vehicle burned for 15 to 20 minutes and emitted dense smoke for about the first 15 minutes. The smoke was too thick to be measured accurately on a pollution scale. The second car was tipped over and holes were punctured into its top and bottom. The seats, tires, floor mats and gas tank were removed and the car set afire. It burned for 10 to 12 minutes, but dense smoke cleared after the first 3 minutes of burning. The burning of junk cars is currently prohibited within the Omaha city limits, but new air pollution control ordinances are under consideration.

68-0354

Transport of wrecked cars—no longer a problem. The mobile KUKA wrecker solves it. Staedtehygiene, 10(11):8, Nov. 1968.

The pickup and transport of wrecked cars is quite expensive nowadays. This is mainly due to the bulkiness of this waste

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material. Not more than two to three car wrecks can be loaded onto a truck. Keller and Knappick GmbH in Augsburg, West Germany, solved the problem by introducing a car wreck which can be easily mounted on a truck. The compacter can be used with all known types of auto bodies. It reduces the volume of the wreckage to 20 percent of its original size, thereby quintupling the loading capacity of trucks. A hydraulic crane loads the wreckage between the two compacting plates and removes it again afterwards. The compacter, too, operates hydraulically. The maximum power of one compacting plate is 36 tons in the center. It takes 5 minutes to compact one auto body (daily capacity: 80 to 120 bodies). The compacter weighs about 7,000 kg, its outer dimensions are: length 7.5 m, breadth 2.45 m, height about 3.3 m. (Text in German)

68-0355

Vehicle burning centres an urgent need. *Materials Reclamation Weekly*, 113(8):15, Aug. 24, 1968.

The organization of car-burning centers by local authorities has been suggested by Scotland as a solution to the disposal problem. These centers could be accommodated in a worked-out quarry, where burning and stripping could be done. Since the new fire legislation was introduced, tires are normally in good shape and would represent an initial salvage asset.

68-0356

Webb, A. W. R. High cost of clearing cars. *Public Cleansing*, 58(12):621-622, Dec. 1968.

Since the Harlow Urban District Council, Great Britain, was authorized to operate the provisions dealing with abandoned cars in the Civic Amenities Act, 1967, voluntary surrender and clearance of abandoned vehicles has gone up to 700 vehicles per year, almost double the previous rate. However, public relations and administrative costs have become a problem. Staff involved has included street inspectors, depot foremen, clerical and accounting, and the senior staff involved in interviewing trade owners. The administrative cost will be at least £1,000 for the year with only an average income of £2 for certain vehicles. The system set up to follow the regulations of the Act required a systems analysis chart, and 17 forms (two printed by the Ministry, five prescribed in the regulations, and 10 for internal use). The briefing of staff for the commencement of the operation has also been complicated.

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68-0357

Announcing a 'new' treated waste product—non-saleable compost. *Compost Science*, 9(2): 2-3, Summer 1968.

Composting may be considered as an intermediate process for treating refuse prior to its ultimate disposal, and not just a method for producing a saleable commodity. Composting is often cheaper than incineration and more sanitary than landfill. It is suggested that companies in the composting business offer equipment for sale to cities including shredders

and grinders, conveyors, digestors, windrow formers, special aerating devices, and temperature controls. A composting contract with a city should provide for disposal sites as well as treatment costs. Shredding and low-cost composting treatment could provide for continued use of many landfill sites, and recycle wastes back into the environment.

68-0358

Biologic decomposition of organic wastes. *Sanitär und Heizungstechnik*, 33(9):539-540, Sept. 1968.

A new method of decomposing organic wastes has been developed by Rikard Lindstrom in Sweden. The method involves relatively little cost. Organic wastes from the kitchen and excreta are collected in a container of special construction. The wastes are decomposed biologically. The decomposed end products can be used as fertilizer. Such wastes as glass and metal are, of course, not disposable by this method. No water must be added. The lower part of the container is completely closed so that no substances can escape into the ground. During the decomposition process, steam and carbon dioxide develop and the volume of the wastes is considerably reduced. The container has three compartments: two are connected to the toilette and the waste collection bin in the kitchen, respectively; the third stores the decomposed end products. The container has openings for air access. The ventilation pipe must be insulated against too much cooling, and, where necessary (in extremely cold climates), it must be heated. This method is suitable for thinly populated, remote areas. Illustrations and a detailed description of the container are given. (Text-German)

68-0359

Calorific value of a sample from the Gainesville Compost Plant, Cincinnati, U.S. Department of Health, Education, and Welfare, 1968.

A determination of the calorific value of undried 'reject' material from the Gainesville Compost Plant was made in order to gain some idea of the heat that would be generated during its combustion in an incinerator. The 'grab' sample consisted of ground paper, plastics, and other light materials removed pneumatically at the ballistic separator and transported by pipe to a burner. A Wiley Mill was employed to reduce the entire sample to particles that could pass through a sieve with 2 mm apertures. The calorific value was determined using a Parr Adiabatic Calorimeter. The calorific value of the sample was 2,969 cal per g. It was concluded that, when burned, each pound of undried reject material will generate approximately 5,344 Btu.

68-0360

Calorific value of samples from windrow 17D at the PHS-TVA compost plant, Johnson City, Tenn. Report SW-RDC P-2. Cincinnati, U.S. Department of Health, Education, and Welfare, May 1968 4 p.

The calorific value of 8 weekly samples of Windrow 17D was studied to determine whether there is any correlation between the heat of combustion, and the age of the compost being processed from a mixture of ground municipal refuse

and sewage sludge. The calorific values were determined using a Parr Adiabatic Calorimeter. Inspection of the analytical data reveals a slight decrease in the calorific value of the compost from day 0 to 7, a slight increase from day 7 to 14, and then a continuous decrease from days 14 through 49. The largest decrease in the calorific value appeared between days 42 and 49. It was concluded that there is a decrease in the calorific value with an increase in the age of the compost after day 14.

68-0361

Cheema, A. S. India develops urban compost-sewage use plan. *Compost Science*, 8(2):13-15, Autumn 1967-Winter 1968.

Two schemes, urban compost and sewage utilization, have been in operation in India to encourage and persuade local governments to utilize urban wastes. While towns and medium-sized cities in general have adopted composting with success, it is in the big cities that the conventional method of composting poses several problems. Mechanized composting offers solutions to the problems of disposal in big cities, including sewage sludge disposal. In order to ensure production of good quality urban compost, standards for separating refuse and reinforcing compost have been suggested. Samples from each compost center must be analyzed periodically. The total expected utilization of sewage is estimated at 50 million gal per day, which would irrigate an area of 70,000 acres. Various measures have been suggested to provide loan assistance to local governments, to provide transport facilities for taking compost to farmers' fields, to requisition land for compost depots, and to train sanitary inspectors in the technique of compost making.

68-0362

Compost utilization and food spoilage. In *The Food Protection and Toxicology Center Annual Report-1967*, Davis, University of California, 1968. 113 p.

The proper utilization of compost is a key aspect in any large scale program of solid wastes management through composting. The research objectives of this project are to: determine the rate and the extent of growth of food spoilage bacteria and fungi during composting of municipal garbage, food processing wastes, and livestock manures; study the effect of such composts on the populations of food spoilage bacteria and fungi in soil; develop techniques and systems for compost production and utilization which will reduce the number of harmful bacteria, bacterial spores, and fungi in the finished compost, the soil, and on raw food products; determine the effects of such composts on the physical and chemical properties of soil which affect its total productivity; and to disseminate the knowledge gained to encourage the use of compost in feed crop production.

68-0363

Compost-turning unit developed by Ohio company. *Compost Science*, 8(2):18, Autumn 1967-Winter 1968.

A new unit, specifically designed for composting waste materials in windrows, is in use at the composting plant in Johnson City, Tennessee. The Cobey Composter is a self-propelled, diesel-powered machine that travels through windrows of materials dumped from a truck or ejected by truck-mounted packer units. The unit is designed to accept

windrows of approximately 8 ft wide by 5 ft high. It can aerate and reduce particle size at the rate of 1,000 to 4,000 tons per hr depending upon density and weight of material. At a Crestline, Ohio, plant, material is processed once every 3 days, and the composting cycle is nearly complete for windrowed material after 14 days.

68-0364

Composting around the world; obstacles to success. In 1968 *Sanitation industry yearbook* 5th ed. p.38-39, 42, 44-46, 48-50.

High labor costs and low fertilizer and peat prices hurt composting. Results of a survey showed that the average gross cost to process 1 ton of refuse was \$4.45 in Europe. The weight of the compost was 46 percent of raw refuse. Average income from compost sales was \$2.73 per ton or 90 cents per ton of raw refuse. Glass, earthenware, paper, and plastics must be removed before treatment. More emphasis is being placed on incineration than composting in the Netherlands. V.A.M. (NV Vuilafvoer Maatschappij) found that transporting compost long distances destroys its economic feasibility. In France, undesirable materials must be disposed of by landfill or incineration, thus adding to overall composting costs. Israeli municipal governments subsidize composting plants. A New Zealand plant earned 42 percent of costs through compost sales. Compost solids will be increased by only 6 to 10 percent by adding sludge, but it will quicken the process and improve the nutrient quality. However, the operation is made more complex and costly. Raw sludge contains harmful germs. There have been complaints of foul odor in the St. Petersburg, Florida, plant. Mobile, Alabama, cannot find sufficient markets. The \$650,000 facility at Johnson City, Tennessee, is studying composting as a method of sanitary and economic disposal. Another demonstration plant is in Gainesville, Florida.

68-0365

Composting operation handles refuse and sludge. *Public Works*, 99(3):84, Mar. 1968.

Disposal of 400 tons of municipal refuse and 120,000 gal of activated sludge is being accomplished daily under a 20-year contract for the City of Houston using the Metro Waste Process. This patented digestion process produces up to 250 tons per day of marketable organic compost. The refuse is first separated to salvage paper, rags, glass, ceramics and metal. The paper and rags, 12 percent of the total refuse input, are baled and sold. A Bird Concurrent Flow Centrifugal thickens the waste-activated sludge, which is added to the refuse to produce higher moisture and increase nitrogen content by 1 to 2 percent. After mixing with the sludge, the refuse undergoes a natural bacterial digestion and breakdown process in digester tanks for 6 days, with process temperatures rising to 165 F. The compost is ground, screened, dried, bagged, and sold for soil conditioning and mulching.

68-0366

Hampl, A. Composting wastes in Czechoslovakia. *Compost Science*, 8(2):27-29, Autumn 1967-Winter 1968.

The main sources of raw materials used in composting plants in Czechoslovakia, in addition to household refuse and

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sewage, are fly ash, industrial wastes, slaughterhouse, fruit, and vegetable wastes, and inferior coal and lignite dust. Each year 450,000 tons of waste are processed in 20 composting plants, which in conjunction with 150,000 tons of peat, yield 600,000 tons of industrial composts. The manufacturing procedure, which on the average takes 40 days, consists of setting up the heap, first shoveling, second shoveling, and shipping. In summer, the proportion of sludges and seasonal waste from food-processing plants is increased. Peat is added in all plants in the proportion of 10 to 50 percent of the total matter of the heap. The product must comply with requirements for homogeneity, structure, odor, consistency, and degree of decomposition. The production cost is primarily affected by the cost of transportation, while the processing itself is simple and inexpensive. The value of increased crops expressed in terms of money is 2 to 3 times the value of the commercial compost applied.

68-0367

Fate of insecticides in composted agricultural wastes. *Compost Science*, 9(3):22, Autumn 1968.

The portion of raw fruits and vegetables, received for preservation by canning or freezing, which is generally discarded as solid waste, has the highest level of insecticide residue. Research was conducted by the National Canners Association Research Laboratories to obtain a better understanding of the degradation of insecticides by microbial or chemical action during the aerobic composting of fruit and vegetable waste from the canning industry. The refuse was composted by conventional batch-type and continuous thermophilic procedures for a period of 120 days, followed by 180 days of curing. Bacteria appeared in the greatest numbers for both compost methods, and were followed by actinomycetes, then fungi. The presence of added insecticides did not influence the numbers of microorganisms or their distribution. The concentration of diazinon and parathion rapidly declined in both processes, while the thermophilic composting was more efficient in reducing the concentration of the organophosphate insecticides, and Dieldrin was more efficiently degraded in the batch process. The curing phase had little or no effect on the insecticide.

68-0368

First-rate compost from refuse. *Farming in South Africa*, 44(4):9, 22, July 1968.

The Dano process produces high-grade compost for farmers needing stabilized, odorless, medically safe humus, free of pathogenic material. One operation realizes the granulation of the dry wastes, the thorough mixing of wastes of all types, the control of moisture content, and the complete aeration of the wastes being treated. Depending on the composition of the raw material, 100 tons of refuse will normally produce about 70 tons of compost. A 50 ton per day plant requires about 2 acres for the plant and stockpiling operation. The compost may be used annually at about 5 to 20 tons to the acre or as landfill.

68-0369

Florida garbage plant makes its presence known too strongly. *The Wall Street Journal*, 171 (30):8, Feb. 12, 1968.

A \$2 million 'showpiece' refuse reclamation plant in St. Petersburg, Florida, has been closed because it produced foul

odors. The facility handled 600 tons of garbage per week and converted it to soil conditioner and fertilizer. The stench arose when bacterial action was interrupted by environmental changes. International Disposal Corporation, owner of the plant, believes the problems are solvable, and, if the odor can be eliminated, hopes to regain the 20-year contract cancelled by the city council.

68-0370

Fuller, W. H., E. W. Carpenter, and M. F. L'Annunziata. Evaluation of municipal waste compost for greenhouse potting purposes. *Compost Science*, 8(2):22-26, Autumn 1967-Winter 1968.

Research was conducted to evaluate the practical use of municipal compost with and without nitrogen and/or soil as a medium for use in growing potted plants under greenhouse conditions. Results indicated that compost appears to have more buffering capacity to protect plants from excessive nitrogen than most organic materials now in use. The greenhouse plants tested responded to use of compost in soil up to soil ratios of 1 to 4. Nitrogen provided additional stimulus to growth. Except for tomatoes, the addition of 0.5 percent N to compost was too high where the compost was used in proportions of 1 to 0, 1 to 1, or 1 to 2. Ammonium sulfate was a poorer source of nitrogen than urea, since it resulted in a higher residual salt content of soil at the same levels of N. The poor growth of chrysanthemum, snapdragon, and gerbera could be attributed more to a serious inhibition by salts than to toxic effects of the soluble N. There is evidence that plants grow better when the nitrogen sources are placed into the compost and the compost-soil mixes are allowed to stand and incubate for a week to 10 days before planting. In general, where more compost is used, less N is necessary for fortification of the compost.

68-0371

Golden, C. A. Studies for the development of procedures and standards for fly-free composting techniques. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint D-1.)

The windrow composting method attracts large quantities of flies. A comprehensive population dynamics study of flies and other arthropods attracted to composting sites is being conducted by the Solid Wastes Program to obtain knowledge for formulation of new compost plant operating procedures to produce fly-free compost. Methods are being studied to effectively conceal, neutralize, or eliminate the more important fly attractants in refuse, gaseous ammonia, and excessive moisture.

68-0372

Harmen, H. Recultivation of waste water dumping areas. *Stadtehygiene*, 19(4):76, Apr. 1968.

Berlin has about 12,000 ha where waste water has been dumped and the soil completely leached out. It can no longer retain water, so that even after short dry periods the vegetation suffers. It was decided to stop dumping waste water and make the area agriculturally usable. This will be done by spreading compost over the entire area. The compost will be a mixture of manure and sewage sludge processed by a

compost-milling machine, which will convert the manure and sludge mixture into ripe compost in 6 to 8 weeks. The odor disappears after the first of three treatments. The milling machine treats as much compost per hr as the crane does per day, namely 150 to 300 cu m, and the loss of nitrogen is reduced to 8 or 10 percent with the milling machine. It is best to mix the compost with soft coal ashes in the ratio three parts of manure and one part ash. The ash adds calcium, magnesium, potassium, and other trace elements. With this kind of compost, the soil has already been rejuvenated so that alfalfa and grass can be grown on the once-exhausted waste water dumping fields. The alfalfa is also the main raw material for the hay drying factory which has been erected in this area, where 15,000 to 20,000 tons of hay are processed. The hay is used for 1,100 cattle, 8,000 pigs, 1,000 sheep, 15,000 ducks, and 5,000 chickens. The animals produce the manure for the compost used on the fields. Thus the cycle is being restored. (Text in German)

68-0372

Hart, S. A. Solid waste management/composting. European activity and American potential. Public Health Service Publication No. 1826. Washington, U.S. Government Printing Office, 1968. 40 p.

The findings of a study, made under a Public Health Service contract, on the status of composting and compost utilization in Germany, Holland, Switzerland, and France, were related to the solid wastes problem in America. The successes of the European plants are not unqualified, and cannot be transferred automatically to the American scene. A survey of 14 European composting plants is included. The results of the study led to the following conclusions: compost in Europe is useful in luxury-type agriculture; compost plus chemical fertilizers can be used in general agriculture; reclamation of strip mined areas with compost offers promise. Public health consideration regarding compost production has been well researched. Compost utilization in the United States appears to have limited potential (commercial utilization of compost for luxury-type agriculture; utilization of low-grade, economically produced compost for land reclamation and cover; and compost spreading onto certain lands, using the land plus the composting process to stabilize organic wastes). Additional studies are needed in the areas of: compost marketing, composting operations costs, wasteland reclamation, pesticides breakdown in organically rich soils, pathogenicity in the actual utilization of compost, and land as an acceptor of wastes.

68-0373

Hortenstine, C. C., and D. F. Rothwell. Garbage compost as a source of plant nutrients for oats and radishes. *Compost Science*, 9(2):23-25, Summer, 1968.

To determine the effects of garbage compost on plant growth, nutrient uptake, and some soil characteristics, 17.6-liter crocks were set in the soil and filled with treatments of garbage compost, sewage sludge, cow and chicken manures, and 10 to 10 to 10 fertilizer mixed with Leon fine sand. Oat seeds were planted in each pot and two cuttings of oat foliage were removed. After the oat roots were removed, radish seeds were planted. Total yields of oat foliage from two cuttings increased progressively within the

compost-treated soil as the amount of compost increased, and were significantly higher than with the control. Yields of fresh radishes and oven-dried tops were greatly increased where the highest rate of compost was applied. It was evident that the 512-ton per ha rate of garbage compost was superior to all treatments. Data include: chemical constituents of organic materials applied to Leon fine sand; influence of treatment of yield and nutrient uptake by oats; influence of treatment on radish yields and nutrient uptake by radish tops; and influence of treatment on some physical and chemical properties of Leon fine sand. The results are discussed, and the presence of various nutrients in the differently treated soils and their effect on the plants are considered. Nitrogen deficiency was noted in the control plants. Yields of radishes that were lower than the control were noted in some cases, with nitrogen uptake by the oat plants being cited as the reason.

68-0375

Jeris, J. S., and R. W. Regan. Progress report on cellulose degradation in composting. *Compost Science*, 9(1):20-22, Spring 1968.

It is the general objective of the study being performed at Manhattan College, under a grant from the Solid Wastes Program of the U.S. Public Health Service, to investigate the environmental conditions required for more rapid cellulose degradation by composting microorganisms. Since paper is very difficult to degrade and is present in large quantities in municipal refuse, it probably limits the rate of composting. Mixed microbial populations were grown on pure cellulose media, and the effect on microbial activity of temperature, pH, agitation rate, inorganic nutrients, and the presence of growth factors was studied. A bench-scale composter was developed and, as a first step, a cellulose substrate was used with newsprint as the only carbon source. A battery of three compost units is in operation, so that environmental parameters can be varied. A system for collecting and analyzing the effluent gases of each unit has been established.

68-0376

Jeris, J. S., R. Regan, and R. Gasser. Cellulose degradation in composting: progress report. New York, Civil Engineering Department, Manhattan College, Dec. 1968. 134 p.

The purpose of the research was to determine the optimum environmental conditions for the composting of cellulose, which is believed to be the material which limits the rate of degradation of refuse. The environmental parameters studied include: temperature, pH, moisture, nitrogen, oxygen, and small amounts of other organic compounds. Laboratory equipment capable of operating at controlled conditions has been developed and operated; it includes three 0.75 cu ft bench-scale composters. Temperature and residual oxygen were monitored continuously with electronic equipment, while other analyses were performed periodically. A shake flask apparatus has also been developed to screen a large number of parameters simultaneously. Experimental results indicate maximum biological growth at 50°C, but growth at higher temperatures has not yet been evaluated. A pH range of 7 to 8, and moisture contents between 50 and 70 percent have given the best results. Small amounts of readily degradable organic compounds and oxygen-enriched air have stimulated the rate of cellulose degradation.

Compost/Composting

68-0377

Kalinske, A. A., and G. L. Shell. Report of studies on composting dewatered sewage treatment plant sludge. In Engineering Foundation Research Conference; Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint D-5.)

The feasibility of composting dewatered waste treatment sludge using mechanical equipment to provide the proper conditions to obtain high-rate destruction of the volatile matter by the thermophilic aerobes is being studied. The dewatering is accomplished by vacuum filtering a mixture of 'fresh' primary and secondary treatment sludge from a conventional trickling filter plant that treats domestic wastes. Composting sewage treatment plant sludge alone, without combining it with garbage and refuse, provides a method of producing an innocuous, odor-free product that may have intrinsic value or may be disposed on land without creating a nuisance. Preliminary studies show that sludge entering the compost has a moisture content of 75 percent, and that after a detention time of 5 to 10 days, the moisture content of the final product is reduced to 35 to 40 percent. The temperature in the composting material was about 140 to 150 F.

68-0378

Kane, B. F., Jr. Development of a thermophilic fungus flora in a municipal waste compost system. M.S. Thesis, University of Florida, Gainesville, 1968. 75 p.

Research was carried out to develop sampling and culturing techniques adequate to the task of defining the thermophilic fungus population that exists during high-rate composting, to follow the development of such a population during routine composting operations, to carefully examine the environmental conditions of composting in terms of the environmental requirements of the thermophilic fungi, and to study their growth under a variety of environmental parameters. The entire study was conducted on one type of high-rate municipal composting system, the Metro Waste Composting Plant in Gainesville, Florida. The compost plant operation and its schematic flow diagram are included. A rich flora was found to be present at most stages in the digestion period. From these samples, 304 unfungal cultures were established including *Aspergillus*, *Chaetomium*, *Humicola*, *Mucor*, *Thermoascus*, and *Torula*. None of the isolates exhibited any special ability to grow anaerobically under the conditions provided. Only *Chaetomium* thermophilus was able to utilize cellulose as a carbon source. The compost mass exhibited a great deal of variation in moisture and gas composition. After the third day of composting, temperatures were unfavorable for growth of the thermophilic fungi in the bulk of the compost. A bibliography is appended.

68-0379

Kerfaw, M. A. Composting—A general review. *Process Biochemistry*, 3(5):53-56, May 1968.

Composting degrades, but does not dispose of refuse. The humus has been used as substitute fertilizer but high cost and the poor quality of the fertilizer produced prevent widespread acceptance of the technique. Sewage sludge improves the natural process and plays the part of an activator. It also can serve as the basis of the organic matter

of the compost. In preparing refuse for use in composting, the aim is to produce an organic residue of uniform size, free from foreign or unwanted matter. By using sludge as an activator and moistener for the refuse, some assistance toward relieving the sludge disposal problem is given. Plants now active in Europe include one which handles the waste of a sugar beet factory. In Scotland, Maidenhead, and Leatherhead in the British Isles, composting is standard practice. In Holland, use of composting is probably the most common. The changing character of domestic refuse raises some problems, since up to 50 percent of some refuse consists of materials not suitable for composting.

68-0380

Klee, A. J. Factors in the variability of physical, chemical, and biological measurements of compost windrows. In Engineering Foundation Research Conference; Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint D-4.)

To insure adequate control of the composting process at the joint U.S. Public Health Service-Tennessee Valley Authority composting project, Johnson City, Tennessee, and to provide satisfactory descriptions of its intermediate and final products, it was necessary to develop statistical sampling programs for various physical, chemical, and biological measurements. Four tests of importance in monitoring the developing compost are: temperature, oxygen, pH, and moisture. The biological tests involved may be classified as indicator organisms or as pathogens. Variability in measurement can result from at least four sources: longitudinal and cross-sectional variability (changes as samples are taken from various locations along the windrow), sampling errors, and analytical errors. Composting schemes have also been evaluated, along with optimum sampling location points and sampling timing strategy, in order to characterize a windrow at a given point in time at lowest sampling cost.

68-0381

Knuth, D. T. Composting of solid organic waste. Battelle Technical Review, 17(3):14-20, Mar. 1968.

Composting, when applied to the disposal of solid organic wastes, is controlled to accelerate the biological decomposition processes which occur naturally. The material requires pretreatment through some degree of waste separation, and then grinding, shredding, or rasping to mix and aerate the wastes. Digestion requires microorganisms, nutrients, moisture, temperature, aeration, and suitable pH. The C/N relationship is optimum at between 30/1 and 35/1, and steps must be taken to adjust the nitrogen content so that decomposition is not slowed, or nitrogen gas or ammonia given off. The maintenance of a sufficiently high temperature is necessary to insure destruction of pathogens, especially if sewage sludge is used to supply nitrogen. The effects of high temperature, used to accelerate the process, and the actual microorganisms involved need further research. The formation of nitrates is also being studied because they are serious water pollutants and may slow the process since most microflora which utilize inorganic nitrogen grow best on ammonium nitrogen. A basic understanding of the mechanisms of composting offers possibilities for product improvement. These products may then be marketed at a competitive price.

68-0382

Kolb, L. P. Municipal composting: some economic considerations. *Compost Science*, 8(2):9-11, Autumn 1967-Winter 1968.

Examples are given of the problems and failures of Phoenix, Arizona, and Mobile, Alabama, in composting municipal refuse due to overly optimistic forecasts of the demand for compost. A study of 21 composting plants around the world revealed an average operating deficit of \$3.38 per ton. A realistic analysis of the feasibility of composting in a given locality should be based on the following considerations: composting is not a money-making operation; the amount of income to be realized from sales of the end product is the critical prediction in any feasibility study; time, money, and talent must be allocated to the development of a market for compost; all possible markets should be explored. A promising new concept for the disposal of the produce of composting plants is the use of the unmatured product in sanitary landfills. The main drawback of this plan is that, although land will be reclaimed, no income will result. Future research efforts are needed to develop a rational method of market prediction, and to develop techniques for tailoring end products to fit local needs.

68-0383

Mercer, W. A., and W. W. Rose. Composting fruit and vegetable refuse; part III: final report. Berkeley, National Canners Association Western Research Laboratory, June 1968, 33 p.

Compost experiments are summarized and methods of analysis of compost are presented. Studies were conducted in an effort to find a solution to the growing solid waste problem generated by fruit and vegetable canning operations. Initial studies were conducted using small-scale, batch-type operations to determine the requirements for composting this raw material. Due to the high moisture content of cannery waste, moisture absorbent materials were necessary to maintain optimum conditions for successful aerobic degradation of the waste. Several types of materials were tested. Rice hulls and sawdust, both waste materials, proved most satisfactory. The fruit waste solids subjected to the composting process were mainly reduced to ammonia, carbon dioxide, and water, thereby leaving little residue to increase the bulk of the compost mass. Objectionable conditions, such as odor and the attraction and breeding of insect and rodent pests, did not develop. To improve the waste handling capacity of the windrows, waste additions were made periodically after the compost mass had attained thermophilic temperatures. With constant provision of raw materials, thermophilic conditions were continuously maintained.

68-0384

Mercer, W. A., and W. W. Rose. Windrow composting of fruit waste. In *Composting fruit and vegetable refuse; part III: final report*. Berkeley, National Canners Association Western Research Laboratory, June 1968, p.2-26.

Two windrows, each 40 ft in length and 9 ft in width, were constructed. To evaluate the effects of forced aeration on the compost mass, perforated copper pipes were imbedded in the asphalt beneath one windrow. Air was supplied by a

positive-displacement rotary blower with a capacity of 12 cu ft per minute. The second windrow served as the control. Waste slurry was applied to the surface of the rice hulls through a flexible 3-in. rubber hose connected to a pipe from the diaphragm pump. Thorough mixing of the wet waste and moisture-absorbing materials was accomplished with the turning mechanism. The windrow was reformed as the mixture was redeposited in front of the machine. Waste additions were made on alternate days, and the windrow turned after each addition. Samples were collected for laboratory analysis before each turning. Temperatures were taken in each windrow at depths of 12 and 18 in. at several points along the length of each row. Degradation of the organic material occurs most rapidly under conditions favorable to the growth of the thermophilic microorganisms. The organisms are most active when environmental temperatures are between 120 and 140 F. The rise in temperature was more rapid than the rise in temperature within the non-aerated control windrow. Changes in pH value of the compost mass served as a secondary indicator of microbial activity, reaching 6.9 on the 12th day. Results of temperature, pH, and moisture determinations are given. Chemical analysis of the rice hulls, fruit waste, and samples of compost at the beginning and end of the experiment are shown. The windrows, turning equipment, grinding equipment, and instrumentation are illustrated.

68-0385

Mercer, W. A., and W. W. Rose. Summary of compost experiments; methods of analysis. In *Composting fruit and vegetable refuse; part III: final report*. Berkeley, National Canners Association Western Research Laboratory, June 1968, p.27-32.

Bin-type experiments-involving fruit waste, produce-house waste, open windrows, and closed-wall windrows-are discussed. Dry materials such as municipal compost, rice hulls, white pine sawdust, and coffee grounds performed satisfactorily in absorption of moisture and maintenance of moisture and porosity of the compost pile. Shredded redwood bark and wheat straw failed to provide conditions necessary for the composting of fruit wastes. The maximum weight ratio of fruit to dry material successfully composted was 250 lb of peach solids to 100 lb of municipal compost. Aerobic conditions in the composting mixture were maintained by a schedule in which an initial turning was done 24 hr after layering the fruit and dry material into the bins, followed by daily turning for 5 to 6 days and turning thereafter on alternate days until the process was completed. Offensive odors did not develop during the composting of fruit waste solids. Produce-house waste, such as that discarded by grocery stores, can be composted when mixed with a dry material such as rice hulls. Windrow composting was found to be a feasible method for study of the disposal of large quantities of fruit waste. Windrows could be turned by machine for the purpose of mixing and aerating the compost mass. With stationary walls, the windrow height of rice hulls could be extended to 5 to 6 ft, resulting in higher internal temperatures. Continuous composting at thermophilic temperatures was shown to be a feasible method for the disposal of fruit wastes. Grab samples of the basic materials and compost mixtures were collected and composted for laboratory analysis. Carbon, nitrogen, phosphorous, potassium, pH, moisture content, and temperature were analyzed.

Compost/Composting

68-0386

Mercer, W. A., and W. W. Rose. Windrow composting of fruit waste solids. *Compost Science*, 9(3):19-21, Autumn 1968.

The National Canners Association Research Foundation initiated a study of the composting process as a possible means of reducing high-moisture organic waste to stable, innocuous material. Bin-type experiments were conducted with fruit and produce-house waste. Rice hulls, selected to serve as a dry material, were combined in open windrows with cannery wastes and aerated by mechanically turning the compost mass. To improve the waste handling capacity of the windrows, waste additions were made periodically after the compost mass had attained thermophilic temperatures. With stationary walls, the windrow height of rice hulls could be extended to 5 to 6 ft, resulting in higher internal temperatures. An automated system was developed to handle the waste, grind and transport the material to the windrow, add the waste, and turn the windrow. Continuous compost operations were found to be a feasible method for the disposal of high moisture organic waste.

68-0387

Mobile compost is selling "Quite Well." *Compost Science*, 9(1):14, Spring 1968.

After a series of problems, the Mobile, Alabama, composting plant is operating without odors and is marketing the product as a soil conditioner in the southeast. The plant uses a series of Gruendler grinders to pulverize refuse, later windrowing the ground material. When the composting plant, which is capable of processing 300 tons per 12 hr, is not operating, city refuse is taken to either of two landfills operated by Mobile. The soil conditioner is bagged in 25- and 50-lb packages and sold in supermarkets, seed and garden shops, and other retail outlets. Much of the compost has been used satisfactorily on lawns, golf courses, parks, flower beds, and nurseries.

68-0388

Modern handling method makes instant waste. *Waste Trade World*, 112(9):13, Mar. 2, 1968.

A complex system of mechanical handling is enabling the City of Leicester to deal with 325 tons of refuse daily. After removal of salvageable materials, the refuse is retained in stabilizers, mixed with sludge, and air is blown into the mass, creating ideal conditions for fermentation. Vibrating screens separate the "fine" material from non-compostable stuff, and the compost is then matured and bagged.

68-0389

Moscow refuse makes good compost. *New Scientist*, 40(621):252, Oct. 31, 1968.

A compost producing plant, capable of dealing with 600 tons of refuse, per day was recently opened near Moscow. Heat for the total operation is provided by burning 150 tons of the waste. An electromagnetic system removes all iron constituents, and nonmagnetic metals are separated with the aid of a high-frequency detector. Glass, china, and stones are crushed to powder in a special hammermill, and elastic and fibrous components are thoroughly chopped. The mixture is

passed into a fermentation tower where it is kept moist and well mixed. Most disease bacteria and weed seeds are destroyed by the relatively high temperature. After a thorough fermentation, the contents of the tower are again sieved. Four days after refuse is received, it leaves the plant as a homogenous compost mixture.

68-0390

Olds, J. Houston compost plant-second year report. *Compost Science*, 9(1):18-19, Spring 1968.

In its second year of a 20-year contract, Lone Star Organics Inc. is receiving \$3.78 per ton for the first 300 tons, and \$3.40 for any excess tonnage from the City of Houston, Texas, for composting its refuse. Comparable costs for an incinerator would have amounted to over \$6 per ton. Approximately 2,000 tons of refuse per week is received, including 75 percent paper and rags, 13 percent garbage, 7 percent tin cans, 1.5 percent large pieces of iron, 2 percent rubber and plastics, and 0.5 percent aluminum and nonferrous metals. Much of the iron, paper, and tin cans are salvaged. A 500-horsepower hammermill grinds the remaining material, which is then conveyed into one of four digestion tanks, each 360 ft long, 20 ft wide, and 8 ft deep, where it stays 4 days. The digesting unit is equipped with two blowers with a capacity of 50,000 cu ft per minute. The final temperature range is 165 to 170 F. The composting bed is turned over by a 15-ton agitator traveling on rails. The finished compost is marketed under a brand name, and other potential markets and uses are being explored.

68-0391

Olds, J. What's the best way to sell compost? *Compost Science*, 8(2):3-4, Autumn 1967-Winter 1968.

It is suggested that the disposal of composted garbage is the responsibility of the municipality where the garbage collection took place. The compost may be spread on privately owned land or government owned land. The application of city-produced compost on county, State and/or Federal land could be set up as a reimbursable program, whereby the city would be allotted so much per ton for having used its compost to improve specified lands. When privately owned composting plants have failed, the reason has generally been because expected profits from sales did not materialize, and the finished compost piled up on plant grounds. City owned compost could be distributed on a schedule best suiting its locale, and thus avoid the problem of stockpiling. If city produced compost is to be sold, it can be sold by existing fertilizer companies which already have markets for their product line. This compost exerts a plant feeding effect in excess of its analysis for nutrients because the nutrients are released slowly to the plant, and humus acts to cause the release of nutrients that are locked up in the mineral fraction of the soil.

68-0392

\$1 1/2 million composting plant closes. *Solid Wastes Management/Refuse Removal Journal*, 11 (5):23, 64, 66, 80, May 1968.

The St. Petersburg, Florida, composting plant has been closed because it was a public nuisance. An investigative committee found (1) lack of preventive maintenance causing frequent

breakdowns; (2) a poor building design; (3) offensive odors; and (4) a malfunctioning dryer which was supposed to remove odors. Beyond the cited nuisance factors, the main reasons for the shutdown are economic. This plant, like all others investigated, has been operating at a loss due to high labor costs, low prices of fertilizer and peat, and high non-organic content in the composting-plant output. Moreover, there appears to be no steady market for the product. Costs of such plants have been underestimated in the past, according to the Office of Solid Wastes. In addition, the presence of plastics and paper and paper products lowers the quality of the material. Studies of plants over the world showed deficits ranging from \$.32 to \$5.32 per ton of compost. Only through subsidization can composting plants continue to operate.

68-0393

Organic soil conditioners for sale. *Compost Science*, 9(2):17, Summer 1968.

Production of Milorganite. Milwaukee's granular activated sewage sludge, has increased to about 80,000 tons per year, and annual sales volume is \$3,500,000. The city compost plant in Mobile, Alabama, is manufacturing a product under the label of Mobile Air Organic Soil Conditioner. The Mobile plant can process 300 tons of city garbage in a 12-hr period, using a series of Gruendler grinders to pulverize refuse, and later windrowing the ground material. The Fairfield Digester System used in Altoona, Pennsylvania, to turn out Fairfield Organic Hum Builder will soon be operating in San Juan, Puerto Rico. In germination and early growth of tomato and pepper seedlings, the compost produced at the Metrogenic plants in Houston, Texas, and Gainesville, Florida, has been found to be superior to sphagnum peat. A Public Health Service Grant has been awarded to Cerritos, California, to study improved sanitary methods of composting manure.

68-0394

Pilot composting plant. Surveyor and Municipal Engineer, 131(3967):51, June 15, 1968.

S. S. Morris, city engineer of Cape Town, stated that should the R400,000 pilot composting plant and incinerator located adjacent to the Athlone sewage treatment works prove practical and economically efficient, substantial extension can be expected in the future. Successful composting will allow the salvage and reuse of large quantities of garbage and other refuse as a marketable product, and will solve the problem of finding new disposal sites. Valuable nutrients and humus-making material would be returned to the soil. The pilot plant treats 40 tons of refuse daily. The product will be conditioned with digested sludge in seven fermentation cells, then aerated for approximately 5 days. Iron will be removed by electromagnets, and the residue pulverized and screened down to -1 size. The material will be stored in a maturation building for 1 to 3 months, depending on the condition of the stabilized compost.

68-0395

Pratolongo, G. The digestion of solid waste in Italy—problems and relative solutions. *Ingegneria Sanitaria*, 16(3):217-220, May-June 1968.

Urban solid waste has a market value in Italy. Depending on its composition, the waste is transformed into fertilizer if it

has a high amount of organic matter, or incinerated to 10 percent of its original volume when a large percentage of its composition is of cellulosic or synthetic nature. In an agricultural economy, the utility of compost is evident. Manufacturing cost of compost varies from 1,800 lire per ton to 2,500 lire per ton. The average sales price is 3,000 lire per ton permitting a profit of 500 to 1,200 lire per ton. To achieve a good compost it is necessary to comminute the organic waste, and then homogenize it so that within 60 days aerobic fermentation has taken place. The best particle size is between 15 to 20 mm, because it results in proper porosity for the fermentation process. If the product is too fine, sulfur-containing compounds may develop, hampering correct fermentation. Good compost must be properly 'stabilized.' When the solid waste contains too many cellulosic compounds, the biodegradability of the substance is considerably slowed. Although compost is of great importance to Italy, mixed plants which can both degrade the waste to fertilizer or incinerate it are preferred, due to their flexibility. The ratio of waste transformed to fertilizer or incinerated will depend upon the plant location. In one case, a 50 to 50 ratio was usual. (Text-Italian)

68-0396

Prochal, P., and A. Schoenowitz. Comparison of physical and chemical properties of composts from municipal refuse in Warsaw, Kielce and Cracow. *Gaz. Woda i Technika Sanitarna*, 42 (10):338-342, Oct. 1968.

Three kinds of composts were examined from plants in Cracow, Kielce, and Warsaw. The first two are open-air field, compost producing plants, the latter makes use of an imposed DANO biostabilizer. Prior to composting, no refuse identification was made and data from literature were used instead. Their tabulation reveals structural resemblance, but proportionality diversities. The operation of the specified three plants is reviewed in terms of the technologies and equipment employed, and the methodology of sampling and testing is indicated in detail. The evaluation was carried out with emphasis on physical rather than chemical analysis, as the former has been neglected so far in all specified composting plants. The results are tabulated, and disclose information about compost weight and bulk densities, size of fractions, and numbers of structural components involved. The chemical analysis reveals satisfactory correspondence of the produced composts to natural manure, possibly suggesting the addition of potassium for quality leveling of composts. It is concluded that the composts examined, representing composts from municipal refuse as such, are suitable for substituting for stable manure, if certain proposed measures are observed during and after composting, and prior to compost field application. (Text-Polish)

68-0397

Fao, T. R. K. Discussion on role of compost plants in India as urban amenity and as a source of organic fertilizer. *Journal of the Institution of Engineers*, 48(6):148-149, Feb. 1968.

The role of compost in India as a method of disposing of refuse and of producing organic fertilizer is considered. Questions relating to the amount of rubbish to be expected from a typical town and costs to be expected from a composting plant and methods of arousing appropriate interest in farmers for the use of such compost are raised.

Also, separation of inert materials such as broken glass, tin, bricks, etc., before the compost is manufactured, is recommended to improve its attraction to users.

68-0398

Regan, R. W., and J. S. Jeris. Cellulose degradation in composting. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint D-2.)

Cellulose, the major component of paper, is biologically a very stable material and is probably the major rate-limiting component when composting is the treatment process. Studies were carried out to determine whether the degradation of cellulose can be accelerated by placing the microorganisms associated with composting under controlled environmental conditions. Microbial activity is measured by carbon dioxide production, the rate of oxygen consumption, and nitrogen metabolism; these are then correlated with pH, temperature, and moisture to define the optimal environment for cellulose breakdown. A medium comprised entirely of newspaper, with added nutrients, is being used. Future studies will be conducted using a representative synthetic refuse.

68-0399

Rohde, G. New technology with efficient compost crusher. *Staedtehygiene*, 1964: 77-78, Apr. 1968.

A group of scientists in Berlin, Germany, has mechanized the natural composting process of cow manure, pig manure, coal ash, and other organic waste material in drying beds. A very efficient crusher, the essential element, having 60 HP, crushes the materials to pieces of 3 to 5 cm in size. It has two operating speeds (about 100 and 200 m per hr). The crusher travels along beds where the manure is spread and crushes it. This process is repeated two or three times. The crushing, mixing, and aerating are performed by a drum in one operating step. After about 6 to 8 weeks, the manure compost is ripe. The advantages of this new composting process are: the loss in nitrogen is reduced to 0 to 8 percent; the manure is decomposed by fungi, rather than by anaerobic bacteria; and pathogenic bacteria are killed by the high temperatures achieved (about 60 C) and by the antibiotic substances produced. This ripe manure compost allows roots to spread and grow deeply, whereas roots do not grow properly in rotting manure. Organic residues can be mixed with the manure compost. Soft coal ash can be added because this will add calcium, magnesium, potassium, and considerable amounts of boron, copper, and molybdenum. Composting can be carried out at any time, even at temperatures below zero. Productivity is much higher than with the crane used at present. The crusher can process 300,000 cu m, while the crane T 172 can handle only 48,000 cu m. The costs of composting are lowered from 2.7 MDN (East German Mark) to 0.5 to 1 MDN per cu m compost. (Text-German)

68-0400

Salable items in refuse. *Public Works*, 99(3): 110, Mar. 1968.

Boulder, Colorado, is employing composting with salvage as a means of refuse disposal. Salable items per ton of refuse

included: 120 lb of cardboard, 80 lb of tin cans, 4 lb of aluminum, 30 lb of other metals, and 8 lb of rags. Non-composting materials, such as glass, plastics, and wood, were removed previously. Six men pick material from a 42-in.-wide conveyor. Refuse remaining after picking goes to a pregrinder, and then to the windrow area.

68-0401

Sibiga, J., and Z. Rewicki. The composting of wastes in Czechoslovakia. *Gaz. Woda i Technika Sanitarna*, XLII(1):18-19, Jan. 1968.

The wastes composted in Czechoslovakia are industrial in character. The chief aim is to obtain organic fertilizers for agricultural needs. The sanitary aspects of waste removal are of secondary importance. The production of compost in Czechoslovakia is carried out according to a fixed program based upon careful observance of the existing stock of wastes forming the raw material for composts. The distribution pattern of the materials used for composting is given, and information about governmental regulations concerning processing and the numerical account of the composting activities in Czechoslovakia in the past is presented. Until 1970 the production of composts should be increased up to a total of 10 million tons of incoming materials. The present utility value of various wastes falls within the range of 5 to 200 crowns per ton. The economic value of various waste components is estimated in terms of their financial equivalents, and the activities of an industrial composting plant in Plana near Ceske Budejovice are described. This plant has been active since 1960, and its present output is about 50,000 tons per year. (Text-Polish)

68-0402

Speight, B. W., J. Kaufmann, L. Creek, and W. L. Gaby. A study of the occurrence and persistence of pathogenic and indicator organisms in refuse sludge composting. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint D-3.)

Investigations were carried out on the use of existing and/or new methods that will allow the quantitative recovery of relatively low levels of pathogens and indicator organisms such as the coliforms, *Staphylococcus*, *Salmonella*, *Shigella*, *Bacillus cereus*, *Endamoeba histolytica*, and *Ascaris lumbricoides* from raw or digested sludge, raw refuse, and compost. The time in the composting process when the pathogens or indicator organisms can no longer be recovered was also determined. The procedures used in examining samples of sewage sludge, raw refuse, and refuse-sludge mixtures taken at various times from the compost windrows are listed.

68-0403

Spohn, F. How ripe is compost? *Staedtehygiene*, 1966: 116-120, June 1968.

The compost made of city wastes is not always produced by microbial decomposition, thus guaranteeing the maturity of the product, but is instead crushed in machines, heated, and treated according to various methods. The product obtained looks like mature compost, but it is just crushed waste or

sludge which may have been subjected to a short rotting process. If piled in a heap, it begins to heat up or mold. The end of these processes, however, is no sure sign of maturity either, but garden cress sown on the compost to be tested will demonstrate its maturity within 5 days. When the cress is cut and weighed, from 10 g of seeds about 60 to 100 g output should result from ripe compost. No germination at all or poor growth are sure signs of an unripe compost. A much faster way to test compost is to grow the fungus *Verticillium cinnabarium* on it. Twenty-four hr after sowing, its growth can be seen with a lens. Dense growth indicates a ripe compost. The only problem with this test is that it is rather complicated, so that it can be performed only in a laboratory. The sulphide test and the nitrogen test also give immediate answers. These methods are based on the finding that the redox potential of fresh wastes is on the reductive side, and, with increasing maturity, moves towards the oxidative side. A favorable redox potential does not necessarily stay that way; lack of air in the compost or in the soil may cause a return to anaerobic conditions, but this occurs less frequently than in unripe compost. When the redox potential is on the oxidative side, the sulphur has been converted into sulfate and the nitrogen into nitrate. (Text-German)

68-0404

Surtawiria, U. A system of composting in West Java, Indonesia. *Compost Science*, 9(2): 22, Summer 1968.

The farmers and gardeners of West Java have practiced composting using a primitive system for many centuries. The Indore system of composting, now carried out by the Department of Agriculture, requires a minimum size for the compost heap of 1 by 2 by 1 m high. The aeration was improved by making vertical holes in the heap with a rod. As a safeguard against fly breeding, the outside edges of the heap are composed of grass material or mud. The compost was generally ready to use after 5 months. More efficient and faster methods of composting involve the use of composting microbes. Composting with the addition of microbes, especially for paddy-straws or paddy-straws combined with municipal refuse required only 4 to 6 weeks. The compost also had a high content of organic matter as plant nutrients.

68-0405

Toth, S. J. Chemical composition of seven garbage composts produced in the United States. *Compost Science*, 9(3): 27-28, Autumn 1968.

The garbage composts that were subjected to detailed examination included: compost sorted to remove glass and metals; sorted compost with sewage sludge, leaves, and grass clippings, or tank manure; ground and unground compost; and finely ground compost. The moisture content values ranged from 9.8 to 33.3 percent. The composts, on the basis of their mean nitrogen, phosphorus pentoxide and potash contents, can be considered to be a 1 to 1.5 to 6.7 fertilizer with a low order of availability. The mean organic matter content was 876 lb per ton, and the ash and acid-insoluble ash contents were high, indicating the presence of inert materials. The total N contents ranged from 0.64 to 1.66 percent. The potash contents were low. The total phosphorus pentoxide was relatively high, probably due to the presence of bone fragments in the composts.

68-0406

Wadie, K. A. O. Soil improvement practices in Ghana. *Compost Science*, 8(2): 17, Autumn 1967-Winter 1968.

The several soil groups in Ghana covering the forest zone, coastal savanna zone, and interior savanna zone are briefly described. In the northern regions of Ghana, on the granitic soils, the farmers practice a settled system of farming in which the land around the compound is cropped continuously. The Extension Service of the Ministry of Agriculture has encouraged farmers to bed their cattle on straw and accumulate as much of the nutrients from the excreta as possible during the night. The compound land receives all the farmyard manure and household refuse. A mixture of grass bedding and animal droppings is periodically applied to cereal crops grown around the compounds.

PROCESSING/REDUCTION

68-0407

Crushing with a hammermill. *Tonindustrie Zeitung und Keramische Rundschau*, 92(6): 227-228, June 1968.

In the course of a paper titled 'Principle and Field of Application of Hammermills', an extensive survey of the production of the HAZEMAG company was given. After the end of the war, crushing machines were systematically and consistently improved. New fields of application opened up. Of the various types of HAZEMAG hammermills briefly described here, only those used for crushing wastes are pertinent. Special hammermills (construction Andres, type M) are used for this purpose. When wastes have been crushed before incineration, the efficiency of the furnaces can be considerably increased. (Text-German)

68-0408

DiFilippo, J. D., and J. F. Malina. Compaction of size reduced refuse. Technical Report EHE 05-6801. Austin, University of Texas Center for Research in Water Resources, May 10, 1968. 63 p.

The changing character of refuse is considered, and quantitative and qualitative aspects of refuse disposal are reviewed. It is suggested that sanitary landfills can be improved with respect to land utilization by size reduction of refuse. Data are presented for the compaction characteristics of composite refuse and individual components, including paper, leaves, ash, glass, tin cans, garbage, wood, and plastics. From the data, predictions can be made regarding the advisability of size reduction. Results of the compaction study indicate that moisture content does not affect the final dry density of compacted refuse; dry weight rather than wet weight of refuse determines the volume of refuse required for a sanitary landfill.

68-0409

DiFilippo, J. D., and J. F. Malina. Literature review. In Compaction of size reduced refuse. Technical Report EHE 05-6801. Austin, University of Texas Center for Research in Water Resources, May 10, 1968. p.3-20.

Data from the literature are presented to illustrate the changing composition of refuse. They indicate a trend toward

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a drier refuse mixture and increased volume of refuse per ton of weight. Because the garbage content of waste is decreasing, hauling garbage to farms presents only a partial solution to waste disposal. Composting has met limited acceptance due to difficulties in applying compost to the land. Incineration has the disadvantage that 25 percent of municipal refuse is noncombustible or not suitable for combustion. Moreover, as indicated from New York City data, incineration processing costs are \$5.55 per ton, as contrasted to the \$0.50 to \$2.00 per ton reported for sanitary landfills. However, landfills can also be uneconomical if the round trip mileage to the fill exceeds specified limits. The tendency toward distant sites could be decreased by making local sites aesthetically acceptable or by constructing the fill in such a manner that it could be used for major construction. One method of improving a landfill for effective land utilization is to improve refuse compaction by particle size reduction. The reduction is accomplished by grinding, shredding, rasping, or similar mechanical action. Size reduction plant costs amount to about \$3.00 per ton processed, less the income from the sale of salvage.

68-0410

DiFilippo, J. D., and J. F. Malina. Procedure. In *Compaction of size reduced refuse*. Technical Report EHE 05-6801. Austin, University of Texas Center for Research in Water Resources, May 10, 1968. p 21-27.

Compaction characteristics were determined for size-reduced composite waste and the following individual components: paper, leaves, ash, glass, tin cans, garbage, wood, and plastics. Materials which were not already size reduced in nature were ground in a Wiley Mill, then placed in a cylinder to determine their uncompacted density. An automatic tamper was used for the compaction tests. The tamping involved dropping a known weight a known distance into a mold containing the sample. Several readings were taken on a sample height. The levels of compactive effort at which heights of a sample were determined were 25, 50, 100, 200, 300, and 400 blows corresponding to 375, 750, 1500, 3000, 4500, and 6000 ft-lb of energy. To determine their moisture content, samples were weighed and dried at 75 C for 48 hr. After cooling to room temperature, the refuse was weighed again.

68-0411

DiFilippo, J. D., and J. F. Malina. Results. In *Compaction of size reduced refuse*. Technical Report EHE 05-6801. Austin, University of Texas Center for Research in Water Resources, May 10, 1968. p.28-43.

Compaction tests were run on size-reduced composite refuse and its components, including newsprint, magazine paper, cardboard, tin cans, plastics, glass, wood, ash, leaves, and garbage. The dry density per cu yd was determined over a range of moisture contents and compaction efforts. For each sample, the mean of all moisture contents at each compactive level was computed, and the standard deviation from the mean determined at each level. The data are shown graphically as compactive effort vs dry density and are tabulated in appendices. Over the range studied, moisture content was not significant for newsprint, cardboard, wood, or composite samples. However, moisture was an important parameter in determining the dry density of magazine paper and leaves.

68-0412

DiFilippo, J. D., and J. F. Malina. Discussion. In *Compaction of size reduced refuse*. Technical Report EHE 05-6801. Austin, University of Texas Center for Research in Water Resources, May 10, 1968. p.44-49.

Compaction tests of size-reduced composite refuse and its individual components demonstrated that dry, rather than wet weight determines the volume required for sanitary landfills. Moisture content did not affect the final dry density of the composite compacted samples studied. In compaction tests at 100 blows, the dry densities of all individual components, except wood, constituted 80 percent or more of the composite dry density. Since the dry densities of the very lightest and most prevalent components are not much lower than composite dry density, it is possible that composite dry density of refuse is at a low point and will increase in the future. Associating lowest moisture content with lowest wet density, and highest moisture content with highest wet density, the range of dry density for a conventional sanitary landfill would be 455 to 765 lb per cu yd. These values compare to the 100 blow compactive level dry density for composite size-reduced refuse of 838 lb per cu yd, and the 400 blow compactive level dry density of 915 lb per cu yd. This indicates that some dry density improvement is attained by size reduction. However, the densities observed do not indicate that size reduction will produce a high grade material unless other modifications are made in the compaction procedure. Mixing with soil is suggested.

68-0413

Equipment for crushing waste and loading it into an incinerator. Wasser, Luft und Betrieb, 12(11):717, Nov. 1968.

To achieve a steady and uniform incineration of waste it is important to crush it first, but problems are encountered in the crushing of waste when it comes to plastic or fiber material from the paper industry. This fibrous waste may block the path from the waste storage room to the loading zone of the incinerator, if it is not shredded first. To avoid this, it is suggested that a screw conveyor with sharp spikes all over its surface be used. The tips of the spike rows have sharp edges which gives them the ability to cut as well as tear. By means of this conveyor, fibrous waste is not only torn but cut into small pieces which enter easily into the loading zone. The inventors of this special type of screw conveyor are Karl Zielenski and Franz Fehle, of Leverkusen, West Germany. (Text-German)

68-0414

Feldman, M. M. Shredding of bulky wastes for New York City. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, H. Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint A-4.)

A project being conducted in New York City is studying the design and construction of a plant to shear and shred a wide range of bulky solid wastes to a manageable size, for either disposal in sanitary landfill, or in preparation for incineration. The bulky wastes will include construction and demolition wastes, household appliances and furniture, logs, obsolete piling and piling, hazardous floating harbor debris, automobile tires, and other difficult refuse. The plant will be

provided with maximum flexibility in being able to feed material either into shear alone, shredder alone, or shear followed by shredder. Material will be received by truck or by barge with emphasis on the former.

68-0415

Japanese firm develops refuse compressor. *Compost Science*, 9(1):22, Spring 1968.

A new invention, the garbecue, consists of a giant hydraulic press, which makes 5 to 7 ton cubes of garbage. When they are threaded with wire and encased in cement, the cubes become building blocks. Covered with asphalt or vinyl, they can be used as landfill, or used under water for making artificial islands or peninsulas. The garbecue creates no nuisance in the way of air or water pollution. There is no odor to the finished blocks, for the heat generated in the press (212 F), along with lack of oxygen, destroys bacteria. Kofu, Sagami-hara, and Yokosuka, Japan will soon have garbecues in operation compressing 300 tons per 24 hr. These units cost \$730,000 each, while a larger unit which can handle 3,000 tons per 24 hr will cost \$7,160,000.

68-0416

Marsden, C., R. R. Farrant, and E. W. Dore. Refuse pulverizing installation, Poole. *Journal of the Institution of Municipal Engineers*, 95 (6): 177-186, June 1968.

A pulverization process for refuse disposal was chosen over incineration, composting, or sanitary landfill by a town with a resident population of 96,000 and an annual refuse tonnage of 35,000. The economy of the town (Poole, England) is based primarily on industry, although holiday trade is important. The four reasons for choosing pulverization were: it provides homogeneous landfill material as required by the Poole reclamation projects; the resulting tip is acceptable within a built-up area without 'covering material'; the processing plant provides a fixed base giving continuity of collection rounds, maximum benefits from salvageable materials, and reduced transportation costs to tip due to bulk reduction in refuse; and it was a most suitable way of increasing daily capacity at the disposal works, while still retaining and utilizing the design capacity of the existing incineration plant. A diagram of the refuse pulverizing installation is given. The design of the plant is discussed with respect to input considerations, reception building and garage, grabbing crane and dust suppression, picking building, the Femascreen building, the discharge building, metal baling, water supply, electrical services, paper baling, civil and structural design, and labor and plant costs. Also discussed in detail are transportation to the tip and land reclamation. Breakdowns of building cost and estimated working expenses are given in appendices.

68-0417

New concept in special duty refuse collection. *Surveyor and Municipal Engineer*, 131(3946):66, Jan. 20, 1968.

To meet problems encountered by cleaning authorities in connection with the collection of trade refuse, sacks, wooden boxes, and cartons, several new features have been incorporated into a compaction vehicle, Compressload 3. The hydraulic loading mechanism crushes the refuse onto the

floor of the rear hopper before feeding it into the body; further compaction takes place through the latter process, so that a total compression is of the order of 3 to 1. The average payload is 3 tons.

68-0418

New pulverisation machinery by A.B.C. Public Cleansing. *58(5):243-246*, May 1968.

A range of machines, designed to meet the pulverization requirements of the majority of refuse disposal processes, has been introduced. One machine possesses novel features, including a horizontal feed arrangement, a converging track pre-crusher and disintegrator, which, it is claimed, simplify basic installation and enable complicated conveying arrangements to be eliminated. The Crusher/Disintegrator is horizontally fed by means of steel converging crushing tracks, and incorporates several safety features. Under a contract with the Greater London Council, a machine will pulverize municipal refuse at a rate of approximately 15 tons per hr. A generous feed entry is provided which will enable, if necessary, bulky waste such as refrigerators, gas stoves, rubber tires, and items of furniture, together with waste-bin refuse to be reduced to a consistent particle size. The installation of these machines also fits in with the needs of landfill operations, incinerator feed, power generation, composting plants, paper shredding, and fragmenting sheet metal.

68-0419

A new waste compacting machine. *Elektrizitätswirtschaft*, 67(18):552, Aug. 1968.

The transportation of wastes always poses a great problem. Wastes have a relatively low specific weight, but they are usually very bulky. Containers with a volume of 4 cu m are capable of transporting on the average only 400 to 600 kg of wastes. But if the wastes are compacted before they are transported, about five to ten times the amount of waste can be transported; for instance, the 4 cu m container holds 3 to 6 tons of compacted waste, and this increases the economy of transportation considerably. For compacting the waste, a machine can be used like that manufactured by the Ries company. The machine achieves a compaction of 1:8 (domestic wastes) and 1:12 (industrial wastes). An illustration of the machine is given. (Text-German)

68-0420

Poole plumps for pulverisation. *Public Cleansing*, 58(7):357-360, July 1968.

A new pulverisation plant in Poole, England was designed to supplement the existing incineration plant and sanitary landfill operation. The process of pulverisation was adopted over disposal by incineration, composting, and sanitary landfill because it produces homogeneous landfill material as required by the Poole reclamation projects; the resulting dump is acceptable without covering material; and the processing plant provides continuity of collection rounds, maximum benefits for salvageable materials, and reduced transportation costs. Extensive experimentation and research concerning the design and construction were undertaken. The plant consists of five Femascreen units. Refuse is emptied

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into a 12 ft deep pit, and transferred by grab into a smaller plate feeder and then to the elevating conveyor. The conveyor transports the refuse from the reception hopper to the enclosed picking section on the top floor of the main Femascreen building, where salvageable material is removed by hand and discharged down chutes to bins. The remaining material passes to the Femascreen drums, and is processed for sanitary landfill. The patented Femascreens are fitted with wire mesh screening panels, and are covered by automatically operated hinged doors. Water is added to the refuse within the Femascreen, which is rotated to break down the material. The hinged doors are then opened and the machine automatically screens out all materials less than two in. in size. Magnetic and dense particle separation are later utilized.

68-0421

Pulverization—sense or nonsense? *Public Cleansing*, 58(9):486-489, Sept. 1968.

Pulverization does not contribute to effective incineration and does not greatly improve a properly run, controlled landfill operation. Good land reclamation practice, coupled with pretreatment of refuse, can treble the cost of refuse disposal with no real advantages for the outlay involved. The only advantage is in a relatively shallow landfill operation where the life of the site could be extended. It is questionable whether the cost of pulverization, coupled with landfill costs, is justified. Incineration should be considered as an alternative.

68-0422

Pulverization at British site reduces matter by 50 per cent. *Solid Wastes Management/Refuse Removal Journal*, 11(2):16, Feb. 1968.

Objections to establishment of a landfill site in a rural area near Worthing, Sussex, were overcome when the operating authority agreed to pulverize the refuse before dumping. The advantages of pulverization are: destruction of most flies, eggs, and larvae brought in with the refuse; rapid consolidation, which, by excluding oxygen from the fill, reduces the danger of spontaneous combustion; and swift settling of the layers which allows tractors and other vehicles to ride on the fill without difficulty. Pulverization reduces the bulk content by approximately 50 percent, thus doubling the useful life of the fill. The smallest economical plant requires an input of approximately 10 tons of refuse per day.

68-0423

Rear-loading compactors. *Solid Wastes Management/Refuse Removal Journal*, 11(1):83, Jan. 1968.

A rear-loading refuse packer in three sizes—18, 20, and 25 cu yd capacities—has been added to the line of solid wastes collection equipment manufactured by Hobbs Trailers. Compaction is controlled from two boxes, one on each side of the hopper at the rear of the unit. The packer plate and loaded hopper are raised by hydraulic cylinders, after which the plate scoops refuse downward and forward into the packing compartment. Safety devices include a toggle switch which can stop the packing cycle at any point. Refuse is compacted at more than 83,000 lb pressure. Expulsion of refuse at the disposal site is accomplished by raising the tailgate mechanism and expelling the contents with a

hydraulic ejection plate which forms the front wall of the main body when it is filled. Control levers for this operation are directly behind the driver's cab. The rear-load mechanism and the hopper descend by gravity.

68-0424

Reeves, E. G. Pulverisation. *Public Cleansing*, 58(6):283-292, June 1968.

Pulverizing can be classified into three groups: (1) fine pulverization of domestic refuse; (2) coarse pulverization of domestic refuse; and (3) pulverization of bulk refuse. Fine pulverizing is achieved by either hammermills or the rotary drum type of pulverizer, coarse pulverization by hammermills or impactor shredders, and reduction of bulk refuse by hammermills or impact breakers. Hammermills operate with a high peripheral speed, but with the disadvantage of not accepting uncrushable material. Therefore, safeguards should be incorporated in the form of magnetic separators or mass detectors. The Gondard and Tollemache units incorporate a ballistic separation section which automatically separates the uncrushable materials. The extensive range of hammermills available incorporates either single rotor or double rotor construction with swinging or fixed hammers and capacities up to 70 tons per hr. The rotor consists of a series of steel discs, located on a horizontally mounted rotor shaft, with fixed or swinging hammers located between these discs. Size reduction is largely controlled by the spacing of the bars within the lower grid. In the Holmes-Hazemag Novorotor Hammer Mill there is no provision for a grate in the base of the mill, the reduction being achieved by hammers with shredding teeth within the discharge section, which eliminates the possibility of choking. Sufficient reserve power is in the order of 50 to 60 percent of the actual absorbed power is essential. The principle of operation in rotary drum type pulverizers is reduction by means of attrition after the addition of a controlled quantity of water. The drums can be circular, octagonal, or hexagonal in cross-section, and units falling into these categories are the Vickers Seordrum, the Femascreen, and the Volund pulverizers of John Thompson Constructions Ltd. The Motherwell Bridge Tacol unit and the Dorr-Oliver refuse treater are also discussed.

68-0425

Reeves, E. G. Pulverization. *Public Cleansing*, 58(7):312-314, July 1968.

The equipment currently available to provide a coarse pulverization of domestic refuse and the reduction of bulk refuse for incineration or sanitary landfill is described. A coarse degree of pulverization is obtained by means of hammermills or impactor shredders, and the article implies that these pulverizers will accept all refuse without any pretreatment or separation. A degree of pulverization is obtained which is coarser than that currently being obtained from high speed hammermills. Jeffrey-Diamond Ltd. has developed a new heavy duty hammermill known as the 'Wakefield Refuse Pulveriser,' which combines the advantages of both the rotary screen and hammer type pulverizers. The peripheral speed is greatly reduced compared to conventional hammermills, and together with large discharge grids, it effectively minimizes reduction by attrition with a reduction of 50 percent in power requirements. The W. C. Holmes-Hazemag impactors have shredders which will accept any type of domestic bulk or industrial refuse and reduce it

to an acceptable size. The impactor shredder is a single rotor machine with a series of cams arranged to intermesh with a series of teeth positioned at the lower end of the two heavy impact plates suspended in the shredder housing. All that is required is a vibrating feeder to ensure even dosage of refuse to the pulverizer. The introduction of these two new designs of refuse pulverizer is an attempt to reduce the high operating costs associated with pulverization, and to offer a unit which will accept all refuse.

68-0426

Reeves, F. G. Refuse disposal-pulverization. *Public Cleansing*, 58(4):156-160, Apr. 1968.

The part that pulverization can play in the treatment of refuse in relation to the accepted means of disposal is outlined. With pulverized refuse, areas of land, particularly shallow depressions which could not have previously been considered for tipping of crude refuse can be utilized. The finer the pulverization, the less will be the need for top covering material. The risk of fires is also virtually eliminated and the tip is largely rodent free. The pretreatment of refuse by pulverization before composting enables unusable components to be rejected and disposed of by some other means. With the emergence of coarse type pulverizers with relatively low operating costs, thought can now be given to the prepulverizing of all refuse prior to incineration. This coarse degree of pulverizing will render the refuse more homogeneous, and because of its constant nature, will ensure an even burn out within the incinerator.

68-0427

Refuse pulverizing plant for Dundee. *Public Cleansing*, 58(3):146-150, Mar. 1968.

Before 1932, over 80 percent of all the refuse in Dundee was tipped, but with the completion of a separation incineration plant which dealt with 100 tons per day, the amount to be tipped was reduced to 80 tons per day. By 1964 the weight of refuse for disposal was 240 tons per day, and all tipping sites had been filled. Pulverization appeared to offer the lowest capital cost, and produced a material which could be tipped without the problems associated with the tipping of crude refuse. A pulverizing plant was built to handle 20 tons per hr of refuse. After separating bulky materials and ferrous materials, the refuse is conveyed to the main pulverizer, a British Jeffrey-Diamond swing-hammer machine. Pulverized refuse is compressed into containers of 28 cu yd capacity by one of four Simon Compactors. A Simon-Morbo rotary stoker will be used to incinerate trade waste which cannot be pulverized.

68-0428

Tip space problem solved at Wallingford. *Surveyor and Municipal Engineer*, 131(3950):76, Feb. 17, 1968.

Shortage of tipping space prompted the investigation of pulverization of refuse which is totalling about 35 tons per day. A single unit Mark II Vickers Seerdum was installed in a simple, prefabricated building. The pulverizer utilizes the wet rotation principle, whereby the tensile strength of refuse is reduced by the addition of moisture, and the turbulence and shearing action of the internal deflection plates causes a rapid breakdown of the original material during a 45-minute

retention period. One of the features of the Seerdum is that the attractive product can be used for shallow filling, without the creation of nuisances, thus increasing tip availability.

68-0429

Wallingford R.D.C. install Vickers Seerdum pulveriser. *Public Cleansing*, 58(4):185, Apr. 1968.

A single unit Mark II Seerdum was installed at the Long Wittenham tip. The unit is loaded by a tractor shovel operating from the reception slab and power is supplied by a 100 kVA diesel generator. Refuse is loaded through an improved design throat, where water is incorporated to establish a moisture content of 40 to 50 percent, a rate of flow indicator being included in the supply line. Wallingford has a population of 21,000 and produces 35 tons of refuse per day. With an input capacity of about 9 tons the installation is readily capable of meeting surge demands and future increases in the quantity of refuse.

68-0430

Waste compactor. *Wasser, Luft und Betrieb*, 12(10):650, Oct. 1968.

At the Hannover (West Germany) fair, a waste compactor was on display which had a compaction power of 30 tons, a lift of 1,100 mm and a loading opening of 1,400 by 850 mm. It operated with a speed of two double lifts per minute. The electronic control equipment of the compactor was installed in a trunk which also held the monitoring device. The compactor switched itself off automatically when personnel came in contact with the protecting rail mounted around the loading zone. When the maximum compaction pressure was reached, a lamp lit up at the trunk, and a buzzer indicated its operating state. The compaction room itself was tightly sealed off after it was filled to capacity. (Text-German)

INCINERATION

68-0431

Bacher, J. H., and E. D. Ranard. Use of mathematical planning models to predict incineration requirements. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.1-11.

Methods were developed to give fairly good estimates of future waste reduction requirements on the county and State level. The methods are less accurate when used on the municipal level. A series of models was developed for the State of Connecticut and could form the basis for similar planning models in other States. The technique of stepwise curvilinear regression analysis was used to generate these mathematical models. The input information necessary to execute these models was taken from a 'transportation' study conducted by Connecticut. The transportation study investigated the effects of land use, population, and manufacturing intensities on highway requirements. A well-known mathematical technique for expressing one variable (tons per day of incinerator capacity) as a function of several others (population, population density, manufacturing employment, etc.) was also employed. A compilation of the Connecticut utilization model 1975

Incineration

projections in term of tons of refuse incinerated per county is presented.

68-0432

Baile, R. C., D. M. Donner, and A. F. Galli. Potential advantages of incineration in fluidized beds. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.12-17.

The potential advantages offered by the fluidized bed furnace for the combustion of a wide variety of solid wastes are presented, along with a description of a fluidized bed. A small pilot plant for the investigation of solid waste combustion is described. The fluidized bed has many potential advantages as a compact low-cost solid waste incinerator. The preliminary experimental runs in the small pilot plant indicated that volumetric heat generation rates in the range of 100,000 to 150,000 Btu per hr per cu ft can be realized. The bed appears stable and the control of the bed simple. The major problems encountered in the pilot plant are associated with feeding waste material into the bed. Two screw feeders were used, a continuous flight and a segmented flight. Neither of these was able to feed the waste materials, including sewage sludge, shredded paper, and shredded garbage. The pilot plant has no provision for the removal of ash from the bed. For almost all of the materials that have been burned, the ash produced has been carried away with the hot exhaust gases. The combustion gas leaving the bed is cooled and passed through a water scrubber. For fluidized beds to burn sewage sludge, the sand bed is completely replaced at suitable intervals. Experience with cans fed to a bed at 1,500 F showed that the tin cans disintegrated and left the bed, whereas aluminum cans remained.

68-0433

Barbetto, M. S., L. A. Taylor, and R. W. Seiders. Microbiological evaluation of a large-volume air incinerator. *Applied Microbiology*, 16(3):490-495, Mar. 1968.

Two semi-portable metal incinerators, each with a capacity of 1,000 to 2,200 standard cu ft of air per minute, were constructed to sterilize infectious aerosols created for investigative work in a microbiological laboratory. Each unit has about the same air-handling capacity as a conventional air incinerator with a brick stack, but costs are about one-third. The units are unique in that the burner housing and combustion chamber are airtight and utilize a portion of the contaminated air stream to support combustion of fuel oil. Operation is continuous. Aerosols of liquid and dry suspensions of *Bacillus subtilis* var. niger spores and dry vegetative cells of *Serratia marcescens* were disseminated into the two incinerators to determine the conditions required for sterilization of contaminated air. With the latter organisms (concentration 2.03 times 10^6 to the seventh power cells per cu ft of air), a temperature of 525 F, measured at the firebox in front of the heat exchanger, was sufficient for sterilization. To sterilize 1.74 times 10^6 to the seventh power and 1.74 times 10^8 to the ninth power wet spores of *B. subtilis* per cu ft, the required temperature ranged from 525 to 675 F and 625 to 700 F, respectively. Air-sterilization temperature varied with each incinerator. This was because of innate differences of fabrication, different spore concentrations, and the use of one or two burners. With dry *B. subtilis* spores (1.86×10^6 to the eighth power per cu ft), a temperature of

700 F was required for sterilization. With dry spores, no difference was noted in the sterilization temperature for the two incinerators. The incinerator installation is illustrated. The incinerator was installed at an cost of approximately \$40,000.

68-0434

Bowen, I. G., and L. Brealey. Incinerator ash—criteria of performance. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.18-22.

Criteria which apply to the degree of burn-out on a furnace burning mixed household and trade refuse are discussed. Emphasis is placed on the ash discharged from the end of the grate, since this represents the bulk of the ash produced by incineration plants. The classical approach to burn-out is to employ 'carbon-in-ash' techniques familiar to combustion engineers designing grates for boiler plants. In Germany, an alternative chemical technique has been developed. The most sophisticated solid fuel technique gives carbon-in-ash between 0.5 percent and 2.0 percent. The following criteria for the completeness of combustion of material leaving the grate are given in order of importance: bulk reduction, odor, lack of mold growth, ability to sustain rat infestation, and contribution to water pollution. Test techniques available for assessing these criteria are described. Actual samples of ash from continental and British incinerators were examined. The data obtained help very little in constructing a test relevant to the odor of ash. In all the tests, the numbers from the heat tests are considerably greater than those from the German method. The test results on unincinerated screened refuse suggest that such material causes no more trouble than clinker emanating from other plants tested. It was concluded that a nitrogen test at 600 C coupled with an air test at 800 C might be the most informative in assessing organic and fixed carbon contents.

68-0435

Brown, R. L. Which dust collector is right for you? *Rock Products*, 71(2):76-80, Feb. 1968.

Scrubbers, bag houses, and electrostatic precipitators offer efficiencies of 99.9 percent and residuals as low as 0.01 g per cu ft. Some questions to consider in choosing equipment are: what is the industrial experience on similar installations; is the dust reusable; is the temperature, pressure, or moisture content a limiting factor; is the dust or gas corrosive? A service offered is that of a test engineer furnished at a per diem rate to formulate and conduct tests on already operating equipment. If the application is unique, pilot equipment is available to determine expected performance. A mobile pilot precipitator is rigidly mounted on a 32-ft semi-trailer. It is single chamber, four to five lanes wide with adjustable spacing, two 4-ft fields with 7-ft field height. The unit was designed to establish precipitator parameters, and to investigate the effect of changing gas conditions on precipitator performance. From the many tests performed, a scale up factor has been established to correlate the results reliably to the full size plate-type unit. A three-tube pilot unit is another example of available test equipment. Other in-plant tools available are the mechanical and electrical test tower, flow laboratory, research and metallurgical laboratory. Specifications should include basic design criteria such as

design pressure, design temperature, and dust density. Hoppers, dust removal equipment, access facilities, insulation and siding, wiring, lighting, unloading storage, and rehandling costs of erection are factors to be considered carefully.

68 0436

Buell, D. Engineers envision Utopian methods-- solid waste disposal-V. Congressional Record, 114(42):S2845-S2846, Mar. 14, 1968.

The Melt-Zit Destructor in Massachusetts operates at temperatures of at least 3,000 F so that combustible materials are completely destroyed. Noncombustibles, about 3 to 5 percent of the total, are discharged from the furnace as a molten stream, which, when cooled, forms a sterile metallic silicate that can be used for shingles, fireboard, road foundations, or subsoil. Before incineration, most of the refuse is sorted. Metals are removed for sale as scrap. Further down the conveyor, lumber is removed for shredding in preparation as mulch. Materials like glass, bricks, and cement are ground into gravel. Fibers and plastics, if mixed, can be used in wallboard. Hard plastics are ground and blended with a solvent in order to produce a crude, yet marketable, plastic. The cost for the complete process is about \$3 per ton. Heat from the equipment can be used to purify thousands of gallons of salt or brackish water, or to produce steam for electricity generation, thus further reducing costs. Garbage is regularly used in a West European process to operate steam turbines. Another innovation is the conversion of surplus World War II Liberty Ships into offshore incinerators, a possibility under study at Harvard University. The wastes would be burned at sea, and the residue disposed of 30 ft below the ocean surface.

68 0437

Buell, D. Weymouth incinerator sets example-- solid waste disposal-II. Congressional Record, 114(42):S2843-S2844, Mar. 14, 1968.

Sixty percent of the original volume of refuse burned at the Somerville, Massachusetts, incinerator remains as residue to be conveyed to a dump. Black smoke and fly ash pollute the air. Smoke is consumed by maintaining 1,400 to 1,800 degree temperatures in the 300-ton daily capacity, \$1,356,000 Weymouth incinerator. If the temperature is too low, dry rubbish is inserted; if too high, wet garbage is inserted. Fly ash is curbed by a \$75,000 scrubbing chamber containing waterspray baffles. A 185-foot chimney helps settle particles. Odors are controlled by spraying disinfectant in storage pits. Only 18 percent remains as residue. Formerly the Weymouth dump accepted only rubbish; garbage was sent to piggeries. Now garbage and rubbish are both incinerated, costing each householder \$5.52 for incineration and \$9.31 for collection annually. A shredding plant in Everett grinds up junk automobiles and bulky wastes.

68 0438

Bump, R. L. Conditioning refractory furnace gases of electrostatic precipitator application. In Proceedings; 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.23-33.

The refractory furnace necessitates a dependable and proven system to handle gases after they emanate from the final

state of combustion, and before they enter the precipitator. Three systems can be used to precondition the high temperature gases. The first is an evaporation cooling tower. In this case, the furnace design terminates with the last combustion chamber, and the tower is installed as a separate piece of equipment. The cooling is done entirely by water. In the second scheme, the furnace design may be such as to accommodate a combination water-air system. The hot gases are cooled partially by water and partially by air infiltration. The final system is one in which the furnace design is such that the cooling is done entirely with water, but in the back end of the furnace rather than in a separate evaporation cooling tower. A typical installation of each system is described. With identical incinerator exhaust conditions from a typical 250-ton furnace, the 'Water and Air Cooling' system results in a 57 percent larger gas volume to treat. The 'Water Cooling' system results in a higher water dew point which is favorable to the precipitator and results in a less conservative sizing factor for that system. The end result is that the 'Water and Air Cooling' system requires a precipitator with a 77 percent larger collecting surface area to do the same collection job as the 'Water Cooling' system precipitator. In the 'Water and Air Cooling' system, the expensive refractory and acid brick lined evaporation cooler is eliminated, and the visible vapor plume at the stack discharge is reduced.

68 0439

Bump, R. L. The use of electrostatic precipitators on municipal incinerators. Journal of the Air Pollution Control Association, 18(12):803-809, Dec. 1968.

Effective control of emissions from municipal incinerator exhaust gases is becoming more important due to stricter Federal and State regulations. Baffled spray chambers give efficiencies in the 50 percent range. Spray cooling chambers are necessary adjuncts to use of a cyclone collector or electrostatic precipitator in the case of a refractory furnace, or water-wall furnace, without a waste heat boiler. Wet scrubbers give efficiencies in the 90 to 96 percent range with a 4 to 6 in. WC drop. Mechanical collectors depend on particle size of the dust and the diameter of the cells with resultant pressure drop efficiencies generally in the 75 to 80 percent range. Electrostatic precipitators require little pressure drop and give efficiencies at times in excess of 99.5 percent. Detailed illustrations of each type of equipment and of the Paris, Munich, and Birmingham, England, electrostatic precipitator installations are included. The operations of these last specific plants are also described. Tabulations include: refractory furnace data; water cooled furnace data; levels of permissible emission and equipment capability; data on specific installations using precipitators; and summary of international refuse composition by percentage.

68 0440

Burckle, J. O., J. A. Dorsey, and B. T. Riley. The effects of the operating variables and refuse types on the emission from a pilot-scale trench incinerator. In Proceedings; 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.34-41.

Since the trench incinerator for the thermal destruction of wastes having a high calorific value and a low ash content is attractive from the standpoints of construction and operating costs, attempts have been made to apply it to the problem of

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disposal of municipal refuse, landscape refuse, and certain industrial wastes. These wastes possess fuel characteristics different from those for which this incinerator was originally designed. Air pollutant emissions were defined for a trench incinerator burning three types of refuse material: low ash, moderately high heat content material characterized by cord wood; high ash, high heat content material, such as rubber tires; and high ash, low heat content material like municipal refuse. Use of a trench incinerator for the disposal of the high ash content materials generated particulate emissions which, in all cases, exceeded 1 grain per standard cu ft at 12 percent carbon dioxide and is, therefore, not recommended. For disposal of low ash, high heat content materials, the data indicate that, except for nitrogen oxides, emission levels from the trench incinerator may be acceptable if rigid operating controls are predetermined for the specific refuse materials. For the disposal of municipal refuse, the trench incinerator is significantly inferior to the multiple-chamber municipal incinerator.

68-0441

Campbell, H. J., and A. L. Friedland. Considerations in incinerator design with respect to community acceptance. In *Proceedings, 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.42-49.

Master planning, for community incinerator design to meet a community's current refuse disposal needs, involves consideration of more factors than just the design of the facility. These considerations fall into two major classifications: social and economic. Sites should be selected in relation to current population densities, anticipated population expansion patterns, projected land use in the area under consideration, the health and comfort of those presently living in areas adjacent to the plant, and the projected total incineration needs of the community. Thought must be given to the future use of the site when it may be no longer economically feasible to operate because of obsolescence, exhaustion of surrounding areas requiring landfill, or a shift in population density. Plans can be made for the future use of both site and structures for such developments as a community recreation area, an industrial park, or the core area for future housing. A typical master plan for an incinerator site showing a typical phase development over a 20- to 30-year period is illustrated. The construction of a plant with a nominal rating of 300 tons per day was recommended to replace an existing 30-year-old, 90-ton plant. The plan included the following actions: acquisition of additional acreage adjacent to the site for residue burial; relocation of offices and demolition of an existing incinerator; construction of a community building; and development of the site to upgrade the area and to utilize part of it for a sanitary landfill which, when completed, would provide a recreational facility.

68-0442

Campbell, H. J., and A. L. Friedland. Incinerators and the public. *Mechanical Engineering*, 90(12):38-43, Dec. 1968.

In the development of an incinerator, design factors to be considered include not only the size and location of the incinerator, but also the possible effects that the incinerator may have on the community. Aesthetic considerations and

plans for possible use of filled land for recreational purposes must be included. The development of plans for a new 300-ton incinerator plant and adjacent recreational facilities is detailed with photographs.

68-0443

Campbell, H. J. Jr., and A. L. Friedland. Planning a municipal incinerator to gain community acceptance. *Civil Engineering*, 38(8):64-67, Aug. 1968.

A municipal incinerator installation requires consideration of many factors. Site selection cannot simply remain a process of choosing a location far from population, or an available piece of land or a site chosen from political expediency. Population densities, trends, available landfill, collection routes, and distances must be considered. Total incineration needs, both present and projected, must be considered. Determination of plant size and capacity should be based on its ability to satisfy present and future community needs. Also, the benefits derived from building, for example, two 150-ton plants, rather than a single 300-ton plant, may outweigh the additional cost involved if an assured continuous burning capacity is thus provided. Plant obsolescence must be considered and the relative merits of various types of equipment considered. The site planner must also consider the use of the plant location for recreational, private, or industrial use after the present function is outlived. Also the actual structure should not be a detriment to the area where it is located. Good design of the building, both inside and out, can have the additional benefit of attracting employees to an occupation which is not now considered desirable.

68-0444

Cardinal, P. J. Multiple hearth incineration. *Water and Waste Treatment Journal*, 12(2):62-67, July-Aug. 1968.

The multiple hearth furnace is the most widely used means of incinerating sludge in the United States. This review of the basic design features of the multiple hearth furnace, when used as an incinerator, includes the general physical design. Data from studies indicate that the sludge varies only slightly in its travel across the drying hearth in both temperature (generally not exceeding 160 F) and in moisture content (between 40-50%) before its entry into the very high temperature combustion hearth. This fact, (that the sludge remains only a very short time at the distillation temperature) accounts for the ability of the multiple hearth furnace to burn the sewage solids effectively, and yet produce no obnoxious odors, even though the gas outlet temperatures are between 500 and 1,200 F. The exhaust gases are scrubbed before discharge into the atmosphere, and the pressure drop associated with such mechanisms has resulted in the use of an induced draft fan instead of natural draft for most furnaces. Multiple hearth furnaces can be automated to any degree desirable. The sludge parameters are considered for most efficient operation of the incinerator and typical parameters, and their Btu values are given to illustrate that incinerators must be prepared to handle a broad range of values. Ash from a multiple hearth incinerator is dry and contains less than 1 percent combustible material. Operating costs are given for several plants and vary by size of plant and according to the characteristics of the sewage. A summary of operating requirements are tabulated for treatment plants

processing wastes of 10,000, 20,000, 50,000, 100,000, and 1,000,000 people. Pertinent data upon which these figures are based are also given.

68-0445

Casimir, D. J., D. McBean, and J. Shipton. Fluidization techniques in food processing. *Food Technology in Australia*, 20(10):466-467, 469, Oct. 1968.

Applications of fluidized processing in the food industry include: freezing and cooling, drying, blanching and cooking, particle coating and instatizing, heat processing of canned foods, and combustion of wastes. The autogenous combustion of concentrated liquid food wastes (20-35% solids) in a fluidized bed without additional fuel has been suggested. The system uses temperatures up to 300 F to achieve complete combustion. It is a complete disposal method, by which every type of fluidizable waste can be destroyed without yielding smoke, odor, visible ash, or any other harmful effluent.

68-0446

Cerniglia, V. J. The consultant's role in furnace design and selection. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p. 50-52.

The problems currently facing the consulting engineer in the design and construction of municipal incinerator plants are discussed. Specific consideration is given to the role of the engineer in the design and selection of the various items of component equipment and the expectations ultimately to be derived from an operating standpoint. Municipal officials are demanding more complete programming of projects, starting with feasibility studies, public presentations, planning for construction costs, and in some instances, advising the actual financing. The consultant is being pressured not only for increased accuracy in cost estimates, but he is expected to assume a greater responsibility in regard to the contractors' and manufacturers' performance as well as the supervision of construction and the ultimate operation of the entire facility. There is a need for a freer exchange of information between consultants on past experience with contractors, suppliers, and/or manufacturers of items of relatively new concept and design.

68-0447

Cohan, E. J., and J. H. Fernandes. The heat value of refuse. *Mechanical Engineering*, 90(9):47-51, Sept. 1968.

Incineration is used for a large variety of wastes. Mixed refuse has a heating value approaching 5,000 Btu per lb as fired, which is equivalent to 10 million Btu per ton of refuse. Figures given indicate that this available energy can generate approximately 100,000 lb of steam per hr, which can be used to generate electricity. A proposal is made for a burning system, not presently in commercial use, which provides the unique features of thermal drying and maximum heat utilization. The refuse, reduced to 2 in. or smaller, is fed into the furnace. The principle of overfeed firing is employed, and the refuse is fed into the furnace at registers high enough to permit drying of the refuse before it reaches the grate at the bottom of the furnace. Turbulence is provided by blowing

tangentially heated air at high velocity at various furnace levels. With proper heat recovery equipment, unit efficiencies in excess of 80 percent can be achieved. A figure illustrates a proposed method by which water-cooled furnaces can be used to affect a tradeoff with air pollution devices without the use of the byproduct steam or hot water. A completely water-cooled furnace can be used to produce hot water for heating and air conditioning systems. At the present time incinerator heat uses may be limited by the down-time of the incinerator plant. The problems may be overcome, and the uses for incinerator-generated steam include not only power generation but: district heating systems or process plants; air conditioning and refrigeration; space and water heating; desalination of seawater; using the condensed steam as superheating energy in a nuclear power plant; and direct hot-gas powering of a turbine (a suggestion for the design of such a system is outlined) which might be the forerunner of a completely self-sustained incinerator plant.

68-0448

Coleman, L. W., and L. F. Cheek. Liquid waste incineration. *Chemical Engineering Progress*, 64(9):83-87, Sept. 1968.

A liquid wastes incinerator has been developed by the Rohm and Haas Co. at its plant near Houston, Texas. The wastes are residues from various chemical processes: gummy organics, light hydrocarbons, waxy solids, and heavy, viscous oils. A range of liquid waste properties is tabulated. The basic requirement was the incineration of the solids in the waste liquids. Design features included an oil burner tip which would pass solids of at least 1/2-in. diameter using small amounts of air, and a combustion chamber which would complete the combustion. Supplementary fuel was used to bring the combustion chamber up to an initial operating temperature of 800 to 1,000 F. The volume of the chamber was calculated by assuming a 100,000 Btu per hr per cu ft of furnace volume heat release rate. Details of the oil burner nozzle assembly and combustion chamber are shown in schematic drawings. The incinerator will burn at least 450 gph without smoke or excess furnace heat. Temperature readings of furnace walls indicated a temperature of 2,070 F, considered to be maximum under present conditions. The basic design of the Houston incinerator could be readily modified for application to a wide range of problems.

68-0449

Criss, G. H., and A. R. Olsen. The chemistry of incinerator slags and their compatibility with fireclay and high alumina. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p. 53-60.

Fused ash on incinerator walls damages refractories and interferes with incinerator operation. Slag samples from the walls of nine municipal incinerators were investigated for chemical composition and fusion characteristics. The differences in behavior of two slags in contact with four types of refractory are shown. Twenty-five individual slag samples were found to vary widely in composition, not only from incinerator to incinerator, but within the same incinerator. The average analysis for silica, alumina, iron, and calcium were found to be close to that of a previous study indicating that there is perhaps a useful typical composition. This average analysis is not unlike blast furnace of cupola

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slags in fundamental chemistry, except that it contains more minor components such as copper, nickel, lead, tin, and barium. Weight change of the samples on ignition was an interesting variable and one that may prove important in predicting slag behavior. Fusion tests on selected slags of widely different compositions show that they can easily become sticky at temperatures where most municipal incinerators operate, and would be readily available to adhere to and/or penetrate the refractory structure. The slag sample with a high ferrous iron content softened and adhered at a substantially lower temperature. In general, superduty fireclay brick appears to be an excellent choice where slag buildup is not a serious problem. For problem areas, a conventional 90 percent alumina refractory appeared to offer no particular advantage, whereas an extra dense, mullite-bonded corundum brick seemed to be advantageous. A phosphate-bonded high alumina refractory showed outstanding ability.

68-0450

Crisp, G. H., and A. R. Olsen. Further investigation of refractory compatibilities with selected incinerator slags. Part II. In *Proceedings, 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.61-68.

Incinerator slag adherence to and penetration into refractories were investigated in the laboratory. The refractory compositions included burned superduty fireclay, high alumina, chrome-magnesite, and plastic materials. Two slags obtained from a continuous incinerator and a batch-type incinerator were used. Two types of tests were conducted. In the usual static type test, 1 in. holes were diamond drilled into the ends of nine-inch brick, and the cavity was charged with the selected slag. The other test consisted of placing 34-g cylinders of slag on pieces of refractory. Both compositions were then heated for 5 hr at either 2,200 or 2,300 F. The test results indicated that phosphate-bonded refractory brick and plastics appear to do well in resisting incinerator slag attack. The 75 percent alumina phosphate-bonded products also appeared to be as resistant to attack as the more expensive 90 percent high alumina refractories. Superduty fireclay brick still would be an excellent choice in many areas of the incinerator, but for problem areas phosphate brick should provide an extended safety margin. The phosphate-bonded plastics should definitely be considered for maintenance and emergency repairs.

68-0451

Cross, F. L., and E. W. Ross. Effluent water from incinerator flue-gas scrubbers. In *Proceedings, 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.69-72.

Florida's new air pollution control standard for incinerator emissions is 0.2 grains per standard cu ft (corrected to 68 F, 1 atm, dry). Florida water quality standards for various chemical constituents and the increase of these constituents in incinerator scrubber effluent are shown. More recent incinerators constructed in Florida have included not only a spray scrubbing system, but also a flooded impingement plate through which the gases have to pass before leaving the plant. Corrosion problems at two incinerator installations are

discussed. It was concluded that in order to meet water quality standards, the scrubber water must be treated to neutralize excess acidity and to remove chemical constituents. The studies indicate that it is perhaps better to keep control on a dry basis rather than to use a wet-scrubber system. Although wet scrubbers are reducing emissions to 0.2 g per cu ft and downwards to 0.1 g per cu ft, dry control methods (bag houses or electrostatic precipitators) can reduce these limits even further.

68-0452

Dalzell, W. H., and A. F. Sarofim. Appendix B. Incineration. In *Summer study on the management of solid wastes: final report*, v.1. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. p.23-33.

A review of the present technology, and identification of the problems that need to be solved in order to reduce incineration costs are discussed. Refuse has an average lower heating value of about 4,500 Btu per lb, compared with values of around 7,800 and 13,000 Btu per lb for wood and coal, respectively. The combustion of refuse is complicated by differences in Btu value and variations in size and moisture content of the feed. Other areas that require investigation are the regulation of the air supply to reduce the amount of excess air, and particulate emissions. If the geographical and economical problems are solved, it is probable that resistance to the acceptance of steam from incineration will be encountered until sufficient evidence is provided that this source of energy will not be subject to the whims of city politics. The ash from incineration is about one-fifth of the mass of the original refuse, and it is useful in construction. Small-scale units have proportionately higher operating costs, and all small units present an air pollution problem. Total costs and cost breakdowns vary widely. Cost breakdown is given for two large modern incinerators as a guide in the orders of magnitude to be expected. Operating costs of two units are also given. A list of recommendations for cities and regional planning are furnished, as well as an outline where research is needed.

68-0453

Day & Zimmermann, Engineers and Architects. Special studies for incinerators; for the government of the District of Columbia, Department of Sanitary Engineering. Public Health Service Publication No. 1748. Washington, U.S. Government Printing Office, 1968. 80 p.

Six separate investigations of disposal of municipal refuse by incineration in the District of Columbia were carried out. Heat and can/metal recovery are examined in depth, since utilization of byproducts is an important aspect. The economics of providing such facilities are also considered in relation to the overall scheme of the proposed plant. Size reduction of bulky metal objects and oversize, burnable waste contribute greatly to the efficiency of the plant; however, this requires the installation of specialized equipment. The economic practicality of utilizing such processes is discussed. The chemical constituents of effluent gases and the air pollution hazards are estimated. An evaluation of various abatement devices is also given. All factors, such as performance standards and aesthetic objections, are reviewed for this feasibility study on the disposal of municipal refuse in a specific area. i., an effort to

aid in the development of incinerator design and operating techniques, a control laboratory is utilized. An itemized list of necessary equipment and installation costs is presented.

68-0454

DeMarco, J., and J. W. Leckman. Guidelines for the design and operation of municipal solid waste incinerators. In Engineering Foundation Research Conference; Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. C-7.)

The Solid Wastes Program has initiated a project to coordinate the technology available to improve incinerator design and operation. Guidelines are being developed with the assistance of a panel of incinerator experts on the following topics: basic data, weighing, receipt and handling practices, furnaces and appurtenances, identification, characteristics, and control of environmental pollutants, instrumentation and controls, heat recovery, salvage and reclamation, special wastes, utilities, and performance evaluation. The guidelines are neither standards nor regulations but are parameters that will minimize environmental pollution and optimize economical and effective incineration.

68-0455

Direct flame method of incineration for combustible solvents. *Air Engineering*, 16(4):32-33, Apr. 1968.

Direct flame incineration, utilizing heat exchangers to conserve Btu's, is a practical system for disposing of solvents from processing systems if looked at from the standpoint of initial investment, maintenance, operating costs, and effective fume elimination. The object of incineration is to destroy the contaminants by oxidation, producing harmless byproducts-carbon dioxide and water. A full-scale direct flame incinerator has been installed in a laboratory to simulate industrial applications. The incinerator is capable of heating to 1,800 F. It was found that combustion efficiencies in excess of 95 percent are available if temperature, turbulence, and time factors are regulated. Due to the variation in solvent concentration, the incineration operating cost will be between \$0.86 and \$1.06 per hr, per 1,000 cu ft per min, when using the Raw Gas Burner System. Heat recovery may be added for a savings of better than 30 percent in operating costs.

68-0456

Engdahl, R. B., and J. D. Hummell. Power from refuse. *American City*, 83(9):119, 121-122, 124, Sept. 1968.

Today, because of the improved methods of collecting and hauling refuse, and the increasing quantities of paper products (usually more than 50 percent), plastics, rubber, and other highly combustible materials, refuse can have a heating value of 5,000 Btu per lb or more. The quantity of such material from a municipality averages between 200 and 250 tons per day per 100,000 population. About a dozen large plants, most of them built since 1964, are burning refuse and generating power in Germany. Two older plants are operating in Switzerland, one in Holland, and a new plant in England. A plant to make steam is now being built in Canada and two are being built in Japan. These plants cost

more than the refractory-chamber incinerators with inefficient air pollution control devices, and American municipalities have avoided them simply because of this additional cost. The electric utilities, both public and private, must enter a new field of operation that involves: the legal aspects of utilities engaging in refuse disposal; the management problems arising when electric utilities work with public or private refuse haulers; different concepts and skills required for the operation of refuse-burning boilers; and modification of the present laws governing utilities to permit them to make a reasonable profit while serving the waste disposal needs of the community. The decision to use refuse as a fuel for power generation depends upon: the dollar value of the refuse as fuel; the cost to utilize the refuse; and the cost of disposing of the refuse by some other means. Cost comparison tables are given. Cities now pay between \$4 and \$7 per ton to incinerate refuse in plants which cannot meet future air pollution control standards, and these costs will rise as more efficient fly ash control equipment is used.

68-0457

Essenhigh, R. H. Burning rates in incinerators. Part I: a simple relation between total volumetric and area firing rates. In Proceedings: 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.87-93.

Of all the problems involved in incineration, one of the more obscure is that concerned with determining the maximum duty or capacity of an incinerator. A simple relation is derived between the area firing rate, the total firing rate or incinerator capacity, and the average volumetric reaction rate. This equation has essentially the same form as an empirical semilogarithmic equation used in practice. Comparison of the two has enabled the calculation of combustion intensities for different waste types. The combustion intensity for a waste with 10 percent moisture is about 18,500 Btu per cu ft per hr, but this drops to 1,400 Btu per cu ft per hr (a factor of 20 difference) as the moisture rises to 85 percent. This influence of moisture is greater than expected.

68-0458

Essenhigh, R. H. Burning rates in incinerators. Part II: the influence of moisture of the combustion intensity. In Proceedings: 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.94-100.

The influence of moisture in reducing incinerator capacity is attributed to the extra thermal load it places on the flame; this so reduces the average flame temperature that the average burning of the waste is significantly decreased. The actual change in flame temperature is quite small, but the effect is greatly magnified by the high temperature coefficient of the reaction. Analysis of published experimental data gave an activation energy of 22 kcal, which is consistent with combustion of smoke. When moisture reduces the flame temperature, the burning time increases, and the input of air and fuel (waste) has to be reduced to let the stay time increase to match the burning time. The reduction in incinerator capacity is directly due to the reduced reactivity of the reactants (mostly smoke, volatiles, and similar gaseous combustibles). The influence of other

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factors directly introduced by the moisture such as dilution, decreased stay time, etc., is evidently negligible. Increase of incinerator capacity is therefore best achieved by increasing the flame temperature. This can be achieved directly by reducing the excess air, if the overfire air mixing can be improved. In the future, the problems to be solved center on maintenance of the combustion in the fuel bed, and on increasing the rate of burn-up of the gases, volatiles, and smoke in the overfire volume of the incinerator.

68-0459

Essenhigh, R. H. Incineration—a practical and scientific approach. *Environmental Science & Technology*, 2(7):524-534, July 1968.

A method for the selection of experiments in incinerator research was formulated and flames of a realistic engineering size were investigated. The concept of successive development of complexity of the pulverized coal flame was later applied to the incinerator problem. Three broad levels of research are discussed. The Building Research Advisory Board recommended for investigation: the design, and size of combustion chambers; the amount, location, and effect of combustion air; the location and distribution of auxiliary heat; and the influence of ventilation. In narrowing the choices for investigation, all levels of research above the test, or idealized, incinerator were excluded. Four areas are now being studied: investigation of the kinetics of waste materials during reaction; combustion study of burning bed behavior in a small combustion pot; cold model studies of the aerodynamic patterns in an incinerator; and construction and instrumentation of a small test incinerator. The research objective is to obtain information on the equations, values of constants, and other factors governing combustion behavior in the incinerator. To identify the possible modes of behavior of an incinerator, the incinerator is regarded as a box with two zones: Zone I—the solid fuel bed through which underfire air is passing; and Zone II—the overbed combustion volume in which gaseous combustibles are mixing with overfire and air. Four possible reaction modes are given.

68-0460

Fernandes, J. H. Incineration air pollution control. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.101-116.

The emission problem, the various methods of incinerator particulate emission control, and their relative costs are discussed. An accurate determination of stack emissions can be obtained only by actual tests based on samples taken in the duct leaving the air pollution control equipment. Air pollution control equipment described and illustrated include the mechanical (cyclone) collector, the wet gas scrubber, the electrostatic precipitator, and the fabric filter collector. The most widely accepted criterion for classifying particulate collection equipment is the weight efficiency. The weight efficiency relates the quantity of the dust collected to the dust that enters the collector with the gas. Another important collector performance criterion is the fractional efficiency curve, sometimes called the size or grade efficiency. The approximate cost of air pollution control equipment per ton per day of incinerator capacity can be developed on the basis of the following assumptions: 600 F

inlet gas temperature; 150 percent excess air; and 5,000 Btu per lb refuse. The capital cost reduction for air pollution control equipment, ID fan, ducting, and stack when the flue gas is cooled indirectly, is illustrated graphically. The interrelationship and a comparison of the various air pollution control equipment systems are summarized with respect to performance, size, and cost.

68-0461

Fichtner, W., and F. Martin. Service requirements of a modern, large refuse incineration plant. In *Proceedings: 1968 National Incineration Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.117-122.

Three main requirements of waste incineration are: the avoidance of water and air pollution by complete combustion of the refuse; low disposal costs by erecting large plants with heat utilization; and continual improvement of combustion techniques. Plants in which waste heat has been utilized can be operated within a collection area comprising the equivalent of to 1 1/2 million inhabitants on an economically feasible basis. The particular combustible properties of the refuse impose design and planning conditions which must be recognized and followed in the layout of the incineration plant, the exhaust gas purification systems, problems of firing control of the grate, the temperatures in the furnace, the discharge of the combustion residues, and the boiler construction. Operating experience is important in order to combat difficulties within the plant; in particular, problems of corrosion. High costs of incineration plant construction can be recovered by suitable plant design, effective utilization of the heat of combustion liberated, and by the proceeds from the sale of byproducts. Two idealized cases of steam generation with refuse were investigated. How the high costs of capital repairs and staff are offset by proceeds, with only a small part of the costs not recovered, is shown for electric power generation and heat supplied to a district heating network, and for electric power generation and sea water desalting.

68-0462

Fife, J. A. Controlled combustion for solid wastes disposal. *Heating, Piping, and Air Conditioning*, 40(3):140-147, Mar. 1968.

Continuous feed and batch-type incinerators for the disposal of typical American refuse are described and illustrated. Furnace stokers, residue removing systems, the supply of combustion air, and furnace heat balance are included in the discussion. Particular emphasis is devoted to furnace design to minimize the size and cost of all downstream air pollution control equipment.

68-0463

Fleming, R. R. Frank answers to some hot incinerator questions. *American City*, 83(5):96-98, May 1968.

The problem of incinerator shutdowns is related to design inadequacies which can be minimized by consulting an engineer with experience in the field. Most failures are probably due to overloading in older incinerators and insufficient draft in new ones. New incinerators must meet new and stringent air codes, and every new device added to

clean the air reduces the draft. The incinerator designed for North Hempstead, New York, needed a 6-in. draft through the furnace train, because it loses 1.5 in. in the water spray and 3.5 in. in the cyclones. Without the 200-hp induced-draft fan, poor burning would occur and smoke would escape through the ports. There is a draft bypass that opens automatically when the gas temperature exceeds 600 F. Consulting engineers and equipment manufacturers can train the staff of an incinerator plant and help insure successful operation. The selection of a Hazemag refuse crusher for the Buffalo, New York, incinerator was made after seeing one operate in Europe. The biggest change in incinerator design has occurred in the field of air pollution control systems. A chart of emission factors for typical incinerators is included.

68-0464

Flower, F. B. Incineration: a method of industrial waste disposal. Presented at Air Pollution Control: Third Annual Conference, Oakland University, Rochester, Mich., Nov. 13, 1968. 11 p.

A paper presented at the Third Annual Conference on Air Pollution Control at Oakland University, Rochester, Michigan, November 13, 1968, listed these reasons why incineration might be selected as the ultimate disposal method: (1) it is the most economical; (2) the waste materials are not suitable for disposal by other methods; (3) incineration gives the need reduction in volume; (4) incineration changes the waste to a nonputrescible and nontoxic material. Everything must be a gas in order to burn. Therefore, generally, it is more difficult to burn liquids than gases and still more difficult to burn solids than gases without air pollution. The completeness of combustion depends upon time, temperature, turbulence, and air. The temperatures within industrial incinerators should be in the area of 1,400 to 2,000 F. The three basic methods of destroying organic gaseous wastes through incineration are by: (1) flares; (2) furnaces; and (3) catalytic incinerators. Bulky solid refuse can be incinerated in a commercial incinerator, provided the material can first be reduced by mechanical means to a manageable size. Bulky refuse can be burned in batch-fed grateless furnace incinerators with secondary combustion chambers. An open trench type of incinerator can often be found satisfactory for bulky refuse with a high heat and low ash content.

68-0465

Fluid bed incinerators studied for solid waste disposal. *Environmental Science & Technology*, 2(7):495-497, July 1968.

Fluid bed units, which are established in the field of sewage sludge incineration, are being considered for solid refuse disposal. Fluid bed techniques have become the basis for many industrial chemical reactions because of the intimate contact that can be obtained between a solid and a fluid phase in these units. Much work has to be done before fluid bed techniques can be applied to the combustion of solid waste. More efficient feeding methods have to be developed, as well as ways to remove the ash and unoxidized materials from the bed. Other problems relate to maintaining an air distribution that keeps solids of varying size and density in suspension in the bed. Fluid beds are compact and simple to operate and control, and cheaper to construct than

conventional grate-fed incinerators. Combustion is rapid and complete with a minimum of undesirable combustion products. A typical fluid bed reactor consists of a lower chamber for distributing the fluidizing gas, a middle section where the desired reaction occurs, and an upper section where the gas passes out of the bed. High combustion efficiencies occur at relatively low and uniform temperatures with little production of oxides of nitrogen. The need for low quantities of excess air is probably the major advantage of fluid bed incinerators. Because of the widely varying composition of refuse, fluid bed refuse incinerators need an auxiliary fuel to maintain stable bed temperatures. A variety of auxiliary fuels is acceptable, including waste low grade coal. Preliminary data runs demonstrated that volumetric generation rates of 100,000 to 150,000 Btu per hr per cu ft can be realized. The major problems encountered deal with feeding material into the unit. Some pretreatment, such as sorting and shredding of the solid waste feed, may be necessary.

68-0466

Goldfarb, I. J., and R. McGuchan. Thermal degradation of polyesters; I. Aliphatic polymers. Technical Report AFML-TR-68-182, Part I. Wright-Patterson Air Force Base, Ohio, Air Force Materials Laboratory, Air Force Systems Command, Oct. 1968. 41 p. (Distributed by National Technical Information Service, Springfield, Va. as Publication No. AD 678883.)

A study has been made of the pyrolysis of eight aliphatic polyesters prepared from various diacids and diols. The polymers start to degrade at about 275 C by random scission of the ester linkage, and they are comparable to polyethylene terephthalate with respect to thermal stability. Providing a beta-hydrogen atom is available in the diol portion of the ester, which was the case for the polymers studied, the classical cyclic mechanism observed for the decomposition of simple esters is applicable. Differences in degradation behavior are best explained in terms of secondary reactions which are dependent upon the nature of the end-groups formed by scission, and on the chain length of the acid and diol used to prepare the polymer. Thus, olefinic end-groups break down to aldehydes, dienes, cyclic ethers, and enols while acid end-groups give carbon dioxide, cyclic ketones, and cyclic anhydrides. Water is produced by anhydride formation and dehydration of hydroxyl end-groups. The overall kinetics were consistent with a random mechanism, but deviations from the simple random picture were concluded for some polymers and probably resulted from cross linking. Kinetic parameters were evaluated from programmed TGA data; activation energies of approximately 40 kcal per mole and preexponential factors of about 10 to the 12th power per minute were obtained.

68-0467

Green, B. L. Boiler for bark-burning. *Power Engineering*, 72(7):52-53, Sept. 1968.

A major southeastern paper mill has been burning bark in one of its boilers for six years. The boiler, which has a rated evaporation capacity of 300,000 lb per hr, is equipped with rotary regenerative air preheaters, and it works on a 75 percent to full load capacity on a continuous basis. When the bark supply is insufficient, the boiler is switched to natural

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gas operation, and the option exists to convert to coal firing should the need arise. The system equipment specifications include: horizontal flow package regenerative air preheater (Ljungstrom), mounted atop the boiler to permit use of boiler-heated air, thus reducing the condensation problem; traveling grate stoker; large tube cyclone fly ash collector; and an hydraulic ash-disposal system. The boiler itself was designed to burn 35 percent bark, and 65 percent natural gas. Operating logs show that the percentage of bark has reached as high as 80 percent. No significant problems in the overall operation have occurred since its installation.

68-0468

Heaney, F. L. Regional districts for incineration. *Civil Engineering*, 38(8):69-72, Aug. 1968.

Studies indicate that substantial savings can be realized by using regional incinerators. A study developed for a municipality of 40,000 persons indicated savings on the order of 40 percent if they join with other nearby communities to form a district of 160,000 persons. In planning an incinerator installation, many preliminary studies are necessary to assure the best criteria for size and location of the incinerator. Actual measurements of representative solid wastes to be disposed are important, and available disposal areas should be catalogued. A topographical survey of the proposed site should be undertaken. Elevations, floor plans, equipment layouts, and costs should be estimated. Labor, utilities, and maintenance cost estimates should be figured for the annual budget. An example of these statistics for a specific set of circumstances is detailed. Air pollution control standards include the provision that the emission of fly ash be less than 0.35 lb per 1,000 lb of flue gas corrected to 50 percent excess air. Electric precipitators have demonstrated a capacity to meet these limits at a cost directly proportional to the volume of flue gas they will handle. Cooling is accomplished best by waste heat boilers. Water sprays or ambient air cooling usually add considerably to the cost of the installation. The background for much of the material presented here was obtained from studies performed in furnishing technical assistance to the Metropolitan Area Planning Council, which covered about 100 cities and towns in eastern Massachusetts.

68-0469

Hoffman, D. A., and R. A. Fitz. Batch retort pyrolysis of solid municipal wastes. *Environmental Science & Technology*, 2(11):1,023-1,026, Nov. 1968.

Pyrolysis, with its concomitant volume reduction, was considered in an application to municipal wastes by the Utilities Department of San Diego, California. Typical samples of actual wastes were used, corresponding to a material bulk density of 4.38 lb per cu ft. The pyrolysis was carried out in a 12-by-4-in. stainless steel retort. The products of the combustible fraction are gases, liquids, and a solid residue. The gaseous products have been studied, and chromatography and infrared spectroscopy methods are now being worked out for the liquid products. Experimental data show the influence of four process temperatures on the quantity, quality, and measured calorific values of products of pyrolytic decomposition. The process can sustain itself by incineration of its products. Should a salvage market exist for any of the gases, liquids, or solids resulting from pyrolysis,

the process may be manipulated to provide a financial return. The residual char is comparable to semi-anthracite coal, and constitutes an easily transportable fuel. The inert solids from the process are sterile and represent satisfactory fill material. Volume reduction is in excess of 50 percent. The capital cost per ton per day of output is tentatively put at approximately 2/3 of that of incineration.

68-0470

Houston orders cleanup: new techniques used. *Chemical Engineering*, 75(6):96-97, Mar. 11, 1968.

An incinerator designed for the treatment of waste oil and the use of refinery waste to nourish a secondary treatment facility are briefly described. High excess-air ratios; high refractory wall temperatures; and a cyclone fire box are some of the features of the new smokeless incinerator. The activated sludge plant will receive ammonia-rich waste water from a nearby refinery to help furnish the necessary nutrient for the bacteria. At the new facility there will be two aeration basins. After aeration and contact with biological cultures, followed by retention and clarification, the water will be discharged. Solid residue will be concentrated, dried, and disposed of as landfill. BOD will not exceed 100 ppm on a monthly average, 125 ppm on any 24-hr average, and 150 ppm for any spot sample at the new plant.

68-0471

Hyde, P. E. Particulate sampling of wigwam burners. Corvallis, Oregon State University, School of Forestry Research Laboratory, Oct. 1968. 12 p.

Present methods for determination of particulate emissions require that calculations and measurements be made of: the weight of all non-gaseous emissions in a sample of flue gas; the volume, temperature, and pressure of this sample of flue gas; and the volume flow of the flue gas stream. A miniature glass cyclone was developed by the Los Angeles County Air Pollution Authority to catch particles larger than 5 microns. A modified Aerotec Dust Collector was used by the Oregon State Engineering Experiment in 1957. The methods and equipment for sampling particulate emission from wigwam burners was considered. The recommended isokinetic sampling train includes: a 7/8-in. diameter sampling probe with provision for velocity equalization by a calibrated-null-balance; hot-wire; anemometer system; a cyclone or dry filter; three Greenburgh-Smith impingers; a dry-gas meter; and a vacuum pump. Differential-pressure measurements to insure isokinetic sampling may be unreliable in wigwam burners because of low velocity of the gas. (From the study: Disposal of Wood and Bark Wastes by Incineration or Alternative Means)

68-0472

Incinerator reduces fire hazards and maintenance. *Plant Engineering*, 22(11):59, May 30, 1968.

A large aluminized-steel industrial incinerator was installed for the burning of Kraft paper, corrugated cartons, and wooden crates. The burning of scrap is contained, thus decreasing potential fire hazard. The unit provides nearly completed combustion, and only a small amount of smoke is released at a height of 89 ft. The cone-shaped burner has a

base diameter of 72 1/2 ft and double-wall construction, resulting in efficient cooling action on the burner and a strong air flow into the upper part of the incinerator. Labor savings have been achieved with the unit because it is no longer necessary to bulldoze material before and after burning.

68-0473

Incinerator spews superclean exhaust. *Chemical Engineering*, 75(12):60, 62, June 3, 1968.

The operation and specifications of a two-chamber trash burner, which burns combustibles in the lower chamber and consumes polluting smokes, odors, and particulates in the upper chamber, are presented. The burner may be charged manually or automatically by conveyor belt. The incinerator can burn waste at the rate of 3 million Btu per hr. Typical test results show Ringelmann O exhausts. Particulate and fly ash determinations average about 0.04 grains per cu ft of exhaust. The trash burner is suggested for industrial, commercial, and institutional incineration; specific applications include loading docks, shipping and receiving rooms, warehouses, terminals, laboratories, and offices.

68-0474

Ishii, K. Incinerator—technical view and recent tendency. Part. 1. *Energy and Pollution Control*, 20(4):19-25, Apr. 1968.

Current incineration facilities and practices for solid wastes and the practical problems associated with them are outlined. Collected refuse is normally brought to storage or directly to the incinerator. While permitting the adjustment of refuse quality and continuous feeding, existing storage facilities present a problem of odors, flies, rodents, and waste water which short storage avoids. After pretreatment such as separation, grinding, and pre-drying, the refuse is thrown into a hopper. Chain grate or reciprocating feeders supply the refuse to drying equipment which utilizes waste gas as a heat source. Incinerators for low grade coal are suitable for refuse, although several incinerators, such as rotary kiln or pit type, are in use. For the gas loop, forced draft is adopted for almost all types. It is difficult to control the temperature range of most incinerators. Since the temperature of waste gas is 200 to 600 C, it is utilized for air and water heaters. Dry and wet ash handling systems are used, depending on the type of incinerator, but the use of the former type is more common. Dust collection is conducted by wet- and dry-type equipment such as cyclone and electrical precipitators. Waste water from the incinerator shows pH 3-5, high suspended solids and a dark brown color, which is hard to eliminate. (Text-Japanese)

68-0475

Ishii, K. Incinerator—problems on design. Part 2. *Energy and Pollution Control*, 20(5):7-12, May 1968.

Refuse may be roughly considered as a mixture of rubbish and garbage. Their ratio in the refuse affects the combustion rate, the air supply rate, the volume of a combustion chamber and size of chimney. The combustion rate and required air supply rate were found to decrease with increasing garbage ratio, while the ratio of required air supply rate to the theoretical air supply rate, which would be a

measure of combustibility, increased with the minimum at a 70-30 ratio. The heat output calculations in the combustion chamber showed that increasing volumes were required with increases in the rubbish ratio. Required draft can be calculated from the frictional loss through conduits and refuse. An increase in the frictional loss with increasing rubbish ratio may be due to the increase in air supply rate and the temperature of the gas. An increase in the frictional loss with the increase in garbage may come from the increasing resistance of the refuse. The height of a chimney can be obtained from draft and gas temperature calculations, which will be proportional to the calorific value. When there is more than 40 percent rubbish involved, a chimney of greater height is required. (Text-Japanese)

68-0476

Jacobson, A. R. Modular incineration system is developed. *Public Works*, 99(7):116, July 1968.

A modular incineration system has been developed to serve small communities—those with populations of 10,000 to 30,000. The solid wastes disposal system consists of factory-assembled modules and includes an incinerator, a receiving and storage building, a conveyor system, an air pollution control system, a stack, a residue system, and instruments and controls. Developed by Combustion Engineering, Inc., of Windsor, Conn., and designed to handle three tons of solid waste per hr, it has a low initial cost, requires a minimum of space, and has low maintenance costs. It has four major elements: materials handling, with sufficient storage capacity to permit accumulating refuse during trucking hours and scheduled downtime; incineration, with refuse being carried by conveyor to the charging bucket and raised to the combustion chamber where it is leveled and advanced until the noncombustibles drop off; residue removal, which features a sealed residue conveying system; and air pollution control, in which gaseous discharges are fed into a gas cleaning subsystem and thoroughly scrubbed.

68-0477

Japanese incineration system for household refuse. *Materials Reclamation Weekly*, 112(26):11, June 29, 1968.

A refuse plant, developed by the Takuma Boiler Manufacturing Co. Ltd, Osaka, has individual furnaces with capacities of up to 500 tons per day, and it has up to four furnaces which can be fed from one refuse pit and charging crane. A feeder at the bottom of the chute controls the movement of the refuse into the furnace. Refuse moving through the furnace is turned by the reciprocating action of three grates. Ash discharges from the last grate, and is subjected to final extract by drag-link through a water seal. Odor is minimized through the use of the air preheater and a fan, which draws combustion air from the sealed refuse collection pit. Combustion on the grates takes place at a surface temperature of 920 to 950 C, with one of two oil burners used to augment combustion below 700 C. Waste gases pass through a primary grit arrester with an air preheater and a bypass section, and are cooled to 800 C by water spray quenching, and then cooled again to 350 C. They then pass through an electrostatic precipitator and a dry multi-cyclone before being blown to the chimney. The use of hot gases quickly reduces the moisture content of the refuse, and the ash flow is carried by conveyor, through water, to the ash pit.

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68-0478

Jerman, R. I., and L. R. Carpenter. Gas chromatographic analysis of gaseous products from the pyrolysis of solid municipal waste. *Gas Chromatography*, 6(5):298-301, May 1968.

The laboratory pyrolysis of solid municipal waste requires a method of analysis for H₂, O₂, N₂, CH₄, CO, CO₂, C₂H₄, and C₂H₆. This paper describes a method by which the above gases are determined qualitatively in a single sample, while quantitative determinations were made employing two samples and two parallel columns. Total qualitative analysis time was 19 minutes. Total quantitative analysis time was 20 minutes. An F&M Model 700 gas chromatograph, equipped with a Model 240 temperature programmer and a gas sampling valve, was used. A Speedomax H recorder, equipped with a disc integrator, was used to record the signal. A four-way selector valve was installed downstream of the gas sampling valve, allowing sample injection on either of the parallel columns. A thermal conductivity detector, equipped with hot wire W-2 filaments, was employed. The full specifications, parameters, procedure, calculations, and results are given.

68-0479

Kaiser, E. R. The incineration of bulky refuse II. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.129-135.

Conventional incinerators are not designed to cope directly with logs, tree stumps, branches, truck tires, demolition lumber, furniture, mattresses, and the like. Tests of two primary chambers of the same general type are reported, and the findings are coordinated. The practicability of hearth-type furnaces for the incineration of oversized burnable wastes was shown. Truck loads containing logs, demolition lumber, furniture, and tires were tractor charged into the furnace. Burning rates averaged 18 lb per hr per sq ft of refractory hearth area. Secondary combustion space is necessary to burn smoke that is generated in the furnace. Fly ash emission is low because of the minimal flow of underfire air. Proposed designs for incineration of 2 to 20 tons per hr are shown. The experience to date on the two bulk-charge furnaces in Detroit and the test furnace in Jersey City provides the following guidelines for future designs: assume charging rate by tractor at 500 lb per minute and not over three charges in succession before door is reclosed; for charging from one door, allow for a furnace depth of 25 to 32 ft maximum and a bridge wall 8 ft high and 13.5 in. thick; assume 7,000 Btu per lb of refuse for mixed air-dried refuse, and 5.0 lb stoichiometric air per lb; supply ample air to the primary chamber to control the gas temperature at the bridgewall, which should not exceed 1,800 F; provide gas residence time in the secondary space of about one second; and provide a rubber-tired tractor with bucket for removing ashes.

68-0480

Kaiser, E. R. Continuous incineration of municipal refuse. In *Engineering Foundation Research Conference: Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. C-5.)

Several years of tests at the Oceanside Refuse Disposal Plant on Long Island, New York, have provided data on refuse

analysis, pit density, residue analysis, and wall temperatures. Studies on the refinement of the heat and material balances for continuous incinerators, the combustion process, and heat transfer are being continued. The testing of the overall process will be developed gradually. By measuring and analyzing the flue gases and residue, a better monitoring of the refuse analysis may be realized than by sampling and analyzing the refuse. The control of under fire stoker air is under development, and the prevention of sidewall slag adhesion by ventilated silicon carbide tiles is being investigated.

68-0481

Kaiser, E. R. Incineration of bulky municipal refuse. In *Engineering Foundation Research Conference: Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. C-6.)

Tests have been completed on two types of tractor-charged furnaces. Applied research is continuing on plant designs in which unshredded bulky items are charged. Several new bulk-charge furnaces, based on the research, are under construction. Because of the field application of moving grates for burning shredded oversized waste, studies of the shredders and performance of the stokers are to be made. The higher burning rates on the grates must make up for the cost of shredding.

68-0482

Kaiser, E. R. Investigation and evaluation of the Melt-Zit high temperature pilot incinerator. In *Engineering Foundation Research Conference: Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint C-2.)

A new method of burning refuse and converting the noncombustibles into a molten slag has been developed. The slag includes glass, ceramics, ash, and metals in oxide form that drain from the furnace into a water bath, where they cool and fragment into a frit of black glassy sand. The pilot furnace is a vertical shaft, chute-charged at midheight with refuse and coke. Forced air is supplied low in the furnace. The coke generates the melting temperature. The incinerator is scheduled for testing to determine the capacity rating of the unit, and the products of combustion, emissions, coke consumption and general performance.

68-0483

Kaiser, E. R. The sulfur balance of incinerators. *Journal of the Air Pollution Control Association*, 18(3):171-174, Mar. 1968.

Available data on the sulfur content of refuse components, incinerator residues, and flue gas are reported. The findings are correlated to establish a judgement as to the approximate sulfur balance for municipal incinerators. Municipal refuse usually contains 0.10 to 0.15 percent sulfur. During combustion a major fraction is fixed in the ash, which contains alkaline oxides. The fixed sulfur apparently occurs as sulfates in the residue and fly ash. It appears that the sulfur content of the fly ash collected and emitted increases with the amount of alkaline oxides present, although the formation of sulfates of iron, calcium, and magnesium is also possible in incinerator atmospheres. It is concluded that the

sulfur in typical municipal refuse is distributed by incineration in large furnaces, half to grate residue, one-fourth to collected and emitted fly ash, and one-fourth to the stack gas as SO₂.

68-0484

Kaiser, E. R., and S. B. Friedman. The pyrolysis of refuse components. *Combustion*, 39(11):31-36, May 1968.

Exploratory tests of destructive distillation of organic wastes, and the prospects for complete gasification of the organic matter are reported. The objective is to determine the quantity and quality of the product gas that might be produced for use as a hot, raw boiler fuel, and possibly for chemical manufacture. The major class of refuse is that from households, consisting primarily of paper products with less than 10 percent each of glass, metal, and garbage, and less than 5 percent each of textiles, wood, plastics, and dirt. Organic matter is basically cellulose but significant amounts of fats, hydrocarbons, proteins, and other organics are present. Ten refuse components from domestic waste were distilled on a laboratory scale, the gaseous products were analyzed, and the yields determined. Gases included mainly CO₂, CO, H₂, and CH₄ with mixture calorific values of 300 to 400 Btu per standard cu ft. By heating to 1,500 F, the organic matter in municipal refuse can be converted to gas, organic liquid, water, and char in roughly equal proportions by weight. Relative yields will be affected by the rate of heating. Higher yields of gas result from rapid heating. Complete gasification of the hot char carbon would be accomplished by supplying air or oxygen with steam.

68-0485

Kaiser, E. R., and W. B. Trautwein. Prevention of fused deposits on incinerator walls. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.136-141.

When fused accumulations of glass, ash, and residue metal occur on the lower side walls of municipal incinerators, the movement of grates and burning refuse is obstructed. To prevent such deposits it is necessary to chill the walls near the burning refuse. A new and successful method of doing this involves the use of steam spray nozzles. These are described in detail, together with test data and costs. In one example saturated steam was available from the incinerator boilers at 450 psi. The affected wall zone was 18 ft long. The fixed grate trunnions along the sidewalls provided opportunity for mounting a steam pipe above the grate. The steam nozzles were 1/8 in. drilled holes, spaced 6 in. apart, for a total of 36 holes. Increasing the steam pressure increased the height of the clean wall surface. Optimum results were obtained with the nozzles angled 6 to 8 degrees toward the walls, and with a manifold pressure of 60 psi. Calorimeter tests showed that the steam entering the manifold was 98 percent saturated. Wall face temperatures were lowered by the steam jets. As the average steam output of the boiler is about 75,000 lb per hr average, the sidewall nozzles consumed about 3.4 percent of the steam output. The gain in furnace performance and steadier steam production more than made up for the steam consumed by the jets. With two 300-ton-per-day incinerators in operation, steam consumption was estimated to cost \$0.42 per ton of refuse.

68-0486

Kaiser, E. R., C. D. Zeit, and J. B. McCaffery. Municipal incinerator refuse and residue. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p. 142-153.

Tests at five municipal incinerators showed various density ranges in the storage bunker and wide variations in the average weight of grapple loads and in the chemical and physical composition of the refuse. Moisture contents of composite samples ranged from 19 to 42 percent. An average refuse analysis and Btu content was derived that is useful for plant design, provided that allowance is made for the seasonal variations in refuse. The average calorific value of organic matter in refuse is no 8,800 to 9,000 Btu per lb, on a dry basis. Paper is 50 percent of the refuse. Together, the percentage of glass and ceramics exceeds that of the metals. The compositions of incinerator residues were determined on two lots which indicate the proportions of metals, glass, clinker, and other materials present. The combined siftings from the stoker grates had a low (3.19 percent) content of combustible matter, essentially equal to that of good grate residue. A physical analysis was made on 782 lb of grate residue from the Stamford, Connecticut, incinerator. The burnout was good; less than 3.5 percent of the remaining material was combustible. Clinkers produced at the Oceanside Refuse Disposal Plant, Long Island, New York contained fused ash, glass, ceramics, and oxidized metal, which accounts for the lower glass and metal content of the remaining residue. The ash analysis and ash fusion temperatures of refuse components indicate that glass is the most readily fusible component but ash from other sources will also fuse at 2,000 to 2,300 F.

68-0487

Kalika, P. W. Influence coefficients to relate municipal refuse variations to incinerator design. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.154-170.

The variability of municipal refuse is difficult to predict or to compensate for in incinerator design. A computer program has been developed which provides influence coefficients which relate refuse variation to incinerator design parameters. The coefficients were found to be relatively independent of most operating conditions, and they were reduced to a handful of brief tables. The coefficients indicate that modest increases in refuse heat content can potentially cause overloading of air, gas, and quench water handling systems, requiring incinerator operation at reduced capacity. Heat absorption equipment could potentially be used to compensate for future changes in refuse characteristics. Selected graphs are presented and discussed.

68-0488

Kenahan, C. B., P. M. Sullivan, J. A. Ruppert, and E. F. Spano. Composition and characteristics of municipal incinerator residues. U.S. Bureau of Mines Report of Investigations No. 7204. [Washington], U.S. Department of the Interior, Dec. 1968. 20 p.

Experiments are detailed in which reliable methods for sampling and analyzing municipal residues were established,

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and the composition and characteristics of the residues were determined. Samples were obtained from a variety of grate-type furnaces and from a rotary kiln furnace. The samples were processed on a batch basis and separated into categories by a variety of methods including screening, magnetic separation, air separation techniques, and handpicking. The main components of the residues were determined to be metal and metal oxides, glass, and ash. Glass constitutes nearly half of the residues by weight, total metallics average over 30 percent. While utilization of these fractions would reduce greatly the volume of landfill required for disposal and would contribute to pollution abatement and the conservation of mineral resources.

68-0489

Kronbach, A. J. A study of incinerator plant space conditioning prepared for Southeastern Oakland County Incinerator Authority, Royal Oak, Michigan. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. C-9.)

Adverse working conditions in the raw refuse handling areas and the residue discharge tunnel, as well as in other areas of the Southeastern Oakland County incinerator plant, are due to inadequate space and contamination of the atmosphere. Three alternate systems capable of meeting the design criteria are discussed. All systems utilize similar equipment such as fans, dust collectors, filters, and precleaners. Careful operation of the refuse cranes and dump trucks can minimize the dust generated. Installation of adequate dust control systems was estimated to cost from \$419,300 to \$463,400 in capital investment funds and annual costs from \$68,100 to \$74,900. After the results of a dust analysis program are ascertained, the economic desirability of the system, the effect on the health of the operating personnel, and the effect on maintaining the equipment will be evaluated.

68-0490

LaChapelle, D. G., J. L. Tarbox, J. C. Maloney, et al. A field-expedient incinerator (Project Tee Pee). Report NDL-TR-98. Edgewood Arsenal, Md., U.S. Army Nuclear Defense Laboratory, Jan. 1968. 132 p. (Distributed by National Technical Information Service, Springfield, Va., as Publication No. AD 664 118.)

The objectives of the Tee Pee field test were to evaluate a portable incinerator that concentrates contaminated combustible materials, and to evaluate any airborne radiological hazard resulting from the combustion process. The Tee Pee combines the concepts that have been proved to be effective in more complex incinerator systems: overfire combustion air for improved gas stream turbulence; a secondary combustion zone to minimize discharge of unburned materials; and tangential firing of burners to induce a rotating gas stream. The components in knocked-down form occupy only three pallets, each 4 ft by 8 ft by 3 ft, so they may be transported by pickup or flatbed truck. The gross weight of the entire Tee Pee system never exceeds 3,000 lb. The incinerator employs five oil-fired burners that ignite the waste material and reduce particulate emissions. Four incinerations or 'burns' were conducted with rough-cut lumber that was contaminated with the radioisotope lanthanum 140. Average burning rates in excess of 600 lb per

hr were achieved. The average weight reduction was 115 to 1. The resultant downwind concentration of airborne contaminant was always below the Maximum Permissible Concentration for the isotope used. It was concluded that the Tee Pee is a practical device for efficient field-expedient incineration and concentration of combustible radioactive waste.

68-0491

LaChapelle, D. G., J. L. Tarbox, J. C. Maloney, et al. Operations. In A field-expedient incinerator (Project Tee Pee). NDL-TR-98. Edgewood Arsenal, Md., U.S. Army Nuclear Defense Laboratory, Jan. 1968. p.8-18. (Distributed by National Technical Information Service, Springfield, Va., as Publication No. AD 664 118.)

The geometry of the Tee Pee was that of a 12-sided truncated cone having a base diameter of 10 ft and a top diameter of 3 ft. Mounted on the top was a 3-ft-high cylindrical screen of 12-gauge locomotive-stack netting which served as a spark arrestor. Total height was 16 ft. The Tee Pee was equipped with 5 oil-fired burners positioned over a 4-ft-deep ash pit. Each of the burners featured continuous ignition and an oil recycle system. In normal operation, the three primary burners were used in the firing mode until the charged material began to burn freely by itself. At this time the primary ignitions were switched off, and the primary burners were used for overfire air supply only. The two secondary burners were fired continuously for the duration of the burn. They served as afterburners to minimize discharge of any unburned material that might arise from the primary combustion zone. Damper air supplied through 6-in. draft dampers provided combustion air and surface cooling. To provide engineering information regarding effluent gas temperatures, effluent flow rates, auxiliary fuel consumption, and surface temperature, the incinerator was outfitted with appropriate instrumentation.

68-0492

LaChapelle, D. G., J. L. Tarbox, J. C. Maloney, et al. Operations (cont'd). In A field-expedient incinerator (Project Tee Pee). NDL-TR-98. Edgewood Arsenal, Md., U.S. Army Nuclear Defense Laboratory, Jan. 1968. p.19-31. (Distributed by National Technical Information Service, Springfield, Va., as Publication No. AD 664 118.)

The incinerator evaluation experiments were conducted in an isolated area on the west central perimeter of Camp McCoy, Wisconsin. The Tee Pee was positioned in such a way that the requirements for downwind sampling of the effluent were met. To sample the airborne effluent, four arcs of filter-type samplers were set up at radial distances of 6, 45, 90, and 180 meters east of the Tee Pee. To sample fallout from the incinerator effluent, aluminum pans were mounted on 1.2-m pedestals downwind from the Tee Pee. A 16-m portable tower, positioned 25 m west of the Tee Pee. A 16-m portable tower, positioned 25 m west of the Tee Pee, was instrumented to provide meteorological data. Radiation counting equipment consisted of a gamma radiation counter and a low beta counter. The short-lived radioisotope La-140 was used to produce both the liquid and the solid fallout simulant. Six hundred board feet of rough-sawn oak lumber, 1 in. thick, was used in each of the four burns. The lumber

for the burns was prepared as follows: burn 1, lanthanum-tagged particles ranging from 75 to 150 microns were affixed to the lumber with a dilute lacquer spray; burn 2, lanthanum-140 in solution was brushed onto the lumber; burn 3, lanthanum-tagged particles ranging from 20 to 75 microns were 'dusted' over the lumber; burn 4, lanthanum-140 in solution was brushed onto the lumber. Personnel outfitted in protective clothing and gas masks entered the pit and shoveled the bulk of the ash into a 20-gal galvanized steel container with lid.

68-0493

LaChapelle, D. G., J. L. Tarbox, J. C. Maloney, et al. Experimental results and discussion. In *A field-expedient incinerator (Project Tee Pee)*. NDL-TR-98. Edgewood Arsenal, Md., U.S. Army Nuclear Defense Laboratory, Jan. 1968. p.32-48. (Distributed by National Technical Information Service, Springfield, Va. as Publication No. AD 664 118.)

Charge activity, ash activity, fallout activity, and airborne and effluent activity data are tabulated and graphed. Average burning rates in excess of 600 lb per hr were achieved. Average weight reduction (the ratio of input weight to resultant ash weight) was 115 to 1. With a variety of simulants and activities, and under the conditions of the experiment, the resultant downwind concentration of airborne contaminant was always below the Maximum Permissible Concentration (MPC) for the isotope used. It was concluded that the Tee Pee is a practical device for efficient field-expedient incineration and concentration of combustible radioactive waste.

68-0494

Laffey, W. T. The incineration of chemical wastes. *Industrial Water Engineering*, 5(6):28-31, June 1968.

The disposal of the byproducts of manufacturing has become increasingly complicated, because solving one problem may create another. Process wastes are generally categorized as gases, liquids, or solids, and various methods other than incineration may be used to reduce or remove them. In using incinerators the design reflects the properties of the three types of waste. A combustible gas must be transported to a boiler installation, making sure no foreign substances are present. If burning in a boiler is not feasible, then the flare stack or other types of controls which maintain the proper air-to-waste ratios should be considered. Liquid wastes must be changed to a gas to burn, and this is usually accomplished by atomizing the liquid to a particle size 40 microns or smaller so it may be volatilized. Highly combustible wastes such as benzene, acetone, etc., can be burned in the open. The design of an incinerator for a partially combustible liquid waste is complicated because the incineration of the waste will take place only after the auxiliary fuel has been completely burned, and all the heat has been released. Several incinerator designs are illustrated and described. Incineration of solids is the most difficult of the three because of their different chemical compositions and forms. The greatest problem is controlling the feed rate. If the material can be reduced to small uniform particles, then the feed can be better regulated. One solid waste incinerator, developed by the DuPont Co. to burn cellulose wastes, features air admitted through a series of closely spaced, high-velocity nozzles which results in thoroughly mixing the air and fuel at

a high temperature. The development of fluidized beds makes use of an air stream, directed into a plenum chamber and through grates into sand at a rate to expand and fluidize the bed, in addition to furnishing the required air for combustion. During incineration, certain products may result that require special equipment for removal, e.g., collectors for particulates or scrubbers for inorganic salts.

68-0495

Marshall, A., G. Crawford, and M. Nolan. Conversion factors for source emission measurements for incinerator flue. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers. p.176-179.

As more government agencies pass air pollution codes and as existing codes become more stringent, the need for incinerator dustloading values has become critical. Since there are two basic units to express source emission dustloading concentrations, formulas are presented for comparison. The initial results of dustloading tests are meaningless without applying the appropriate correction; both a 50 percent excess air and a 12 percent carbon dioxide correction standard are in widespread usage. In any dustloading test, the type of refuse or fuel being consumed, the temperature and pressure of the atmosphere, and the components of the flue gas must be taken into account. The formulas presented include these variables. All the formulas have been based on the assumption that the fuel or refuse being burned only contains carbon, hydrogen, and oxygen. Furthermore, all the formulas have been derived on a dry basis. Since the percentage of carbon monoxide is normally zero or very small in a proper incinerator operation, its effects on the conversion and correction formulas have been neglected. A special slide rule has been developed which greatly simplifies the use of various formulas.

68-0496

Matsumoto, K., R. Asukata, and T. Kawashima. The practice of refuse incineration in Japan. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers. p.180-197.

The history and development of Japanese refuse incinerator facilities up to the present are described. Prior to World War II, the majority of refuse incinerators used in Japan were small, batch-fed, fixed grate furnaces. The government passed emergency legislation in 1963 calling for environmental facilities. Refuse in Japan has a far higher moisture content and lower calorific value (heating value 500 to 1,300 kcal per kg, 40 to 70 percent moisture content) than that of Europe or America. To completely burn this refuse at high temperatures, the Japanese have used continuous-feed mechanical incinerators which are equipped to preheat the air used for combustion. Drying equipment has also been used to decrease moisture content. A reciprocating stoker which properly shakes the refuse layers must be used to prevent blow-off. The performance of the stoker is a highly important factor from the standpoints of operation, maintenance, and control. The hot gas drying method, in which combustion gas is recirculated for drying, and the operation of typical incinerators employing this type of drying equipment, are described. Incinerator flue gas corrosion problems are being studied. Diagrams of various Japanese incineration plants are included.

Incineration

68-0497

Matusky, F. E., and R. K. Hampton. Incinerator waste water. In *Proceedings; 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.198-203.

The effluent water from residue-quenching and fly ash-conveying incinerator plants is contaminated by dissolved and suspended matter. The waste water from five plants, which have various grate designs and fly ash-handling systems, was investigated to establish the amount and characteristics of the contamination. Furnace capacities vary from 90 tons per day to 250 tons per day, with two to four furnaces per plant. Water sampling was done during normal operation, and analyses were made by independent testing laboratories. Some of the measurements that were taken to describe the waste water were: temperature, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, hydrogen ion concentration, alkalinity, solids tests, and odor tests. Comparing incinerator wastes to the typical sewage, it was found that the odor characteristics are about the same. Depending upon the amount of the entrainment of the gas in the scrub water, it is possible to have either an acid or basic reaction in the residue conveyor. Alkalinity ranges are higher than those for sewage. Total solids are high in residue conveyors and fly ash-handling systems, ranging from 1,300 to 12,000 ppm or 0.1 percent to 1.2 percent. Suspended solids are low. The BOD is generally less than that of sewage. Water conservation by reuse and improved residue quenching is indicated as a means of minimizing the problem. Odor control may be achieved by chemical sterilization of closed water systems.

68-0498

McAteer, D. J. Incineration of sewage sludge. *Process Biochemistry*, 3(4):60-62, Apr. 1968.

Use of a multiple hearth furnace to incinerate sewage sludge and produce completely inert solids has advantages in that it is odor free, and unlike other furnaces designed for incinerating waste materials, has no open burning grate. The furnace consists of a series of horizontal, refractory hearths positioned one above the other. A vertical rotating shaft moves the material across the hearth to the drop holes through which they fall to the hearth. There are three zones in the furnace: drying, combustion, and cooling. Distillation of volatiles from the sludge takes place in the combustion zone where temperatures from 1,450 to 1,600 F burn them completely, thus eliminating obnoxious odors. Temperatures at the furnace outlet may vary from 500 to 1,200 F. Design considerations for a multiple hearth furnace used to burn sludge are given; also given are calculations on the requirements for autothermic combustion. The most important factors are moisture content, volatiles and inerts, and the calorific value of the combustibles.

68-0499

McLouth, B. F., H. J. Paulus, and A. J. Roberts. Incineration of epoxy glass laminates to recover precious metals. In *Proceedings; 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.171-175.

A St. Paul, Minnesota, firm was faced with an air pollution problem that dealt with the recovery of precious metals from

electrical circuits, printed on epoxy-impregnated fiber glass laminates. This recovery meant incineration of the scrap and the rejected printed circuits, which liberated a considerable amount of unburned hydrocarbons and obnoxious odors. A prototype unit with an afterburner was successfully tested, and plans were made for a new incinerator with a feed-door arrangement to provide adequate charging facilities, and to be as gas tight as possible. The combustion chamber was to have a volume of 191 cu ft and the afterburner chamber a volume of 43 cu ft. Twenty ft of 16-in. refractory-lined stack would raise the stack discharge to approximately 38 ft above the incinerator base. A control system was designed that should assure proper burner operation and unit temperatures, and at the same time be flexible in case adjustments were necessary. After several weeks of testing, the incinerator was accepted by the company. Because of the variance in type and consistency of the epoxy scrap, trained personnel must be in constant attendance during the first several minutes of each firing period. The new incinerator simplified the recovery of the precious metals by producing more consistent ash quality. This helps defray the cost of fuel consumed by the three burners. Polyesters and other plastics, as well as wool and vinyls, have since been burned in this incinerator, all with equal success.

68-0500

Michaels, A. What good incineration means. Part I—history. *American City*, 83(5):83-86, May 1968.

Since World War II, several changes in American living habits have become apparent, and these changes have profoundly affected solid waste disposal practices generally, and incineration in particular. The movement of people into urban areas has increased congestion and reduced the availability of waste disposal space. Packaging changes increased the quantity of waste contributed by each individual and reduced the amount of organic garbage in the waste. The concentration of people in urban areas also increased the concentration of pollutants in the air, water, and land, resulting in stringent pollution laws. At present, the per capita rate of refuse production is increasing at a rate of 2 percent per yr, which, when compounded with a 2 percent per year population growth, results in an overall increase of 4 percent per year. Since recognizing that incineration is a complex process requiring the application of sound engineering principles, incineration engineers have made significant advances in the design and operation of incinerator plants. Since heat value is the primary factor in computing furnace sizes and combustion air requirements, the need for obtaining refuse characteristics becomes obvious. A recent design for an incinerator was based upon burning refuse containing a combined total of 30 percent moisture and noncombustible waste. To obtain a heat value, the designers assumed that all the combustible waste was cellulosic with a heat value of 8,360 Btu per lb, or assumed that the waste to be burned contained a heat value of 8,360 Btu per lb times .70, equalling 5,850 Btu per lb. A recent bomb-calorimeter test of several samples in this refuse showed that it had an average heat value of 5,770 Btu per lb.

68-0501

Michaels, A. What good incineration means. Part II—design parameters. *American City*, 83(6):88-90, June 1968.

The materials handling function can be divided into four categories: refuse receiving and storage; furnace charging;

conveyance through the furnace; and residue removal. Most plants use the overhead traveling crane to convey waste from the storage pit to the furnace. For many years, a majority of the incinerators in America operated on the batch charge principle. A majority of the new incinerators use movable grates to convey the refuse to the discharge area. Today, the three most popular types of grates in the continuous charge plant are the chain or bar and key traveling grate, the rocker arm grate, and the reciprocating grate. Residual removal systems include direct discharge into a dump truck or container, discharge into a water trough equipped with a chain flight or pan-type conveyor, and discharge into a sluicing trough. These equipment and methods do an acceptable job in handling 'normal' municipal refuse within limits, but problems arise when unusual materials or moisture conditions develop. The most troublesome of these waste materials at the present time are oversized burnable wastes including building demolition materials, discarded furniture, and tree and brush waste. To date, no American community has developed a plant capable of handling oversized burnable wastes. The combustion function can be divided into three categories: ignition, combustion, and gas cleaning. To meet designing limits, an incinerator should operate at temperatures between 1,300 and 2,000 F. At present, most urban communities permit particulate emissions of 5 to 10 lb of fly ash per 1,000 lb of refuse processed. This represents a removal efficiency of 60 percent. The wet baffle impingement and dry mechanical cyclone systems are discussed.

68-0502

Monroe, E. S., Jr. The incineration of aqueous wastes. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.204-210.

An increasing number of incinerators are being built to dispose of aqueous wastes that may contain only traces of combustible material. The three basic methods of treating aqueous waste by incineration are treatment: by heating only, by saturated vapor heating, and by superheating vapor. The Schutt process is an example of the first method, which involves only the heating of the aqueous waste. Calculations were made to determine the variables involved when the aqueous waste was only to be heated with combustion products. The second basic method covers the area of heating and partial or complete evaporation. If an aqueous waste contains organics with high boiling temperatures, then the organics can be concentrated and sprayed into the combustion flame to burn. Another area of application for saturated vapor heating is the control and recovery of solid emissions. The third method is that of combining heating and evaporation of the water, and superheating the resultant vapor directly in a flame. If the aqueous waste is injected into a flame properly according to the principles previously stressed, the water will be superheated as well as evaporated. The system is applicable for small streams, where the relatively high fuel costs may be less than equipment depreciation and the maintenance costs required for more complex systems. For large streams, a careful evaluation of the superheated vapor incineration versus the evaporation incinerator should be made. Calculated data are presented for the significant variables that govern temperature and heat input. A review of flammable zones is given.

68-0503

Monroe, E. S., and C. T. Hayes. Incineration. In *Industrial waste disposal*. New York, Reinhold Book Corporation, 1968. p.190-239.

Incinerators are usually classified by the type of waste they burn—gas, liquid, or solid, although combinations of these types are found. Incinerators are also classified as direct flame and catalytic. When this is done, the incinerators are being classified according to their method of operation. With all types, however, the best way to rate the capacity of an incinerator is to establish the total amount of heat it can process in an hour. In practice this requires some analyses of the chemical and physical composition of the industrial waste. Subsequent calculations relate the analyses to the final design of the incinerator. There is some discussion of how this is done in the case of direct flame and catalytic incinerators.

68-0504

Montreal incinerator: design for a better environment. *Public Works*, 99(10):128, Oct. 1968.

Montreal's Incinerator No. 3 will have four furnaces, each rated at 12.5 tons per hr. and they will have 20 percent continuous overload capabilities. The refuse storage pit is large enough for 48 to 60 hr of full scale operation. At an anticipated load factor of 87 percent, the incinerator will process 335,000 tons of refuse per year. A special type of shear-crusher will accommodate bulky items. Steam, produced by the operation, will be utilized in various ways. Air pollution control features will include the use of electrostatic precipitators to reduce the emission of dust to less than 0.15 lb per 1,000 lb of gas.

68-0505

Morgan, J. E., and C. M. Saul. The Zimmermann process in a soda pulp mill recovery system development of a commercial process. *Appita*, 22(3):60-75, Nov. 1968.

The Zimmermann or 'wet combustion' process has been applied at a pulp and paper mill to chemical and heat recovery from black liquor produced by the soda process (zero sulphidity) of alkaline pulping. For a black liquor treatment system, virtually complete oxidation is required for maximum chemical and heat recovery. The conventional evaporation, incineration, and dissolving steps in the recovery circuit were replaced by a new process which has proved to be efficient. There is no fume loss and negligible chemical loss. The recovery of thermal values as usable steam is significantly higher than conventional practice. Pilot plant experiments with a continuous reactor, which showed that the process was technically feasible, are described. It was found that a reaction temperature of 608 F and pressure of 2.925 pound-force per square inch would be required to oxidize 97 to 99 percent of the organic matter to carbon dioxide and water. A solution of sodium carbonate/bicarbonate, suitable for causticization, was produced. A commercial unit, equivalent to a 30 long ton per day pulp mill capacity, which has been in production for a year, is described. The performance and operation of the unit is discussed in relation to the predicted chemical and thermal recovery efficiencies. A comparison with present recovery

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practice indicates the future of the Zimmerman process in large alkaline soda pulping mills. Pilot plant and commercial plant flowsheets are included.

68-0506

NAPI member designs low-cost incinerator. *National Engineer*, 72(1):8-9, Jan. 1968.

Edward T. Knox has received a patent on his design of a municipal incinerator which reportedly will sell for about half the cost of present equipment. The unit uses a series of jet heads, usually 111 per unit, and is constructed of air-cooled firebrick. This air is used in an overfire air combustion medium. The one-man unit operates without grates, does not require a holding house for debris, and is electrically automated. The incinerator is batch fed by one or more receiving hoppers; each holds 15 cu yd of debris at one time and is located on the outside of the incinerator. The unit does not have a smoke stack, is 92 to 97 percent smoke free, and causes no water pollution.

68-0507

New driftwood incinerator for New York Harbor. *Public Works*, 99(9):99-100, Sept. 1968.

An open pit incinerator with controlled overfire air to deal with the approximately 600,000 cu ft of driftwood from New York harbor is being constructed to replace open burning on two large incinerator barges anchored in the upper bay. The furnace is a box-shaped structure measuring 25 ft by 20 ft by 17 ft. A 2-ft layer of sand at the bottom will act as a buffer. The capacity is estimated at approximately 10 tons per hr. With the furnace loaded to 2/3 of volumetric capacity and with a bulk density of 25 lb per cu ft, the charging capacity for the furnace is 62.5 tons. Combustion air is supplied at three levels of the furnace on all three sides. The ignition system is three retractable gas burners with 5-ft flame lengths. The drift-collection vessels will transfer filled nets of driftwood directly into a dumping pan which accommodates two net loads and which spills its contents directly into the center of the furnace. Air pollution control will utilize manual control of the overfire and sidewall air, and a water spray curtain over the fire will clean the gas and prevent the escape of burning embers. Residue is expected to be minimal; however, the expanded metal screen on top of the unit can be removed by a truck crane to give access to the pit. The cost of the new facility is estimated to be \$2 million, and it is expected to be ready for tests by early 1969.

68-0508

New incinerator test facility helps solve air pollution problems. *Industrial Heating*, 35(8):1464, Aug. 1968.

A new, large and versatile incinerator has recently been installed in the Research Laboratory of Surface Combustion Division, Midland-Ross Corp., Toledo, Ohio. This facility was developed to incinerate samples of waste materials quickly, and to establish requirements applicable to different types of available incinerator designs for disposal of oxidizable waste chemicals and vapors. As a typical example, industrial solvent fumes have been incinerated, resulting in 98 percent conversion of hydrocarbons. In addition, this experimental system will be used for the development of equipment

improvements and determination of optimum operating conditions for waste disposal, with strict control of key variables. A photograph of the incinerator is shown.

68-0509

Nowak, F. Corrosion problems in incinerators. *Combustion*, 40(5):32-40, Nov. 1968.

Use of refuse as fuel for steam generation plants engenders many problems including heavy deposits, more frequent outages, and gas-side corrosion of heating surfaces. It is impossible to compare incinerators with boilers fired with gas, oil, or coal. The reasons are the inhomogeneity of the waste materials and the corrosive components of the flue gas. An examination of the various types of corrosion and erosion which are likely to occur and the temperatures involved are given, as well as recommendations for boiler construction to alleviate these conditions. Measures taken in the design of the firing equipment and furnace serve to increase operating periods and protect heating surfaces. This makes incinerator plants possible which can generate steam at pressures and temperatures comparable to other thermal power plants, thereby making use of the heat and realizing some cost return. Illustrations show flow conditions in primary and finishing superheater, zones of highest corrosion in refuse furnaces, material losses in refuse furnace, and various examples of material loss of components.

68-0510

Ohio incinerator installation planned. *Clean Air News*, 2(16):4, May 1968.

Two new municipal incinerators planned for Montgomery County, Ohio, will have four scrubbers to clean the flue gas. The installation will reportedly be the largest in the world to incorporate wet scrubbing. Designed to handle as much as 220,000 cu ft per hr of incinerator flue gas at 2,000 F, each Peabody scrubber has an internal diameter of 15 ft 6 in. The designed cleaning capacity is for an outlet dust loading of 0.5 lb per 1,000 lbs of flue gas (corrected to 13 percent CO₂), with a total pressure drop across the unit of only 4.5 w.c. Apart from removing solid particles, the scrubbers will also remove gaseous pollutants such as sulfur and nitrogen oxides.

68-0511

O'Malley, W. R. Special factors involved in specifying incinerator cranes. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.211-215.

One of the most important components in handling of waste is the overhead bucket crane used to transport refuse from the storage bins through rehandling and mixing, and then to the incinerator furnace hopper. This material handling duty cycle is always continuous and always strenuous. Five classes of cranes are defined and distinguished. These classifications allow the crane builder to arrive at a number of frame capacity ratings. An effective incinerator crane must provide bearings, gearing, shafts, and structures able to withstand the rigors of the most severe duty. The planned capacity of the incinerator plant must be determined, and a layout of the area must be prepared which delineates the size and location of all bins, furnaces, and hoppers. The structural aspects of a

good crane specification are tightly bound to structural considerations in the incinerator itself. Deep-carburizing of wearing parts is an important consideration. Depending on the type of refuse involved, the crane will be equipped with either a grab bucket or a grapple. Electrical design features that should be considered are: motors, crane control apparatus, speed control devices, and conductor systems. Provisions must also be made for spare parts, instruction of operators, and call-back service as a basic responsibility of the crane builder.

68-0512

Oviatt, C. A. The effects of incinerator residue on selected marine species. In *Proceedings of the Annual North Eastern Regional Antipollution Conference*, University of Rhode Island, Kingston, July 22-24, 1968, p.108-110.

Research was conducted to determine the effects of municipal incinerator residue on marine life so that predictions applicable to large-scale dumping can be made. Another objective was to determine the physical characteristics of a suitable offshore dump site. Bioassay experiments were used as the basic method for evaluating the toxicity of incinerator residue. The species used for the experiments in order of resistance were: the quahaug, the common mummichog, juvenile winter flounder, first and second stage lobster larvae, the common prawn, juvenile menhaden, and the sea scallop. Of all species tested, the sea scallop showed the highest sensitivity. An incinerator residue component with particles less than 12 mm in diameter appears to have a low grade toxicity to which some species are sensitive. Angular particle shapes of the residue may be the cause of observed mortality. Species not sensitive to the residue appeared to thrive on it. The incinerator residue apparently improved the sediment environment for the quahaug. At a designated dump site, even low-grade toxicity and solution and decay of the material could not prevent this area of the bottom from becoming harmful to marine life because of the increasing amounts of material that is dumped. The problem is actually one of containment.

68-0513

Pagan, A. R. A sequel-solving the problems of a pit incinerator. *Public Works*, 99(2):84-85, Feb. 1968.

Some problems have been associated with the operation of the Bergen County, New Jersey, low-cost, forced-air pit incinerator which serves as a means of extending the useful life of existing landfill areas. Since the structural integrity of the incinerator has been impaired by constant pounding and push-feeding material into the pit through a chute, the walls of the pit were rebuilt from the concrete base using an 11-in. thick reinforced concrete wall with reinforcing bars. Two layers of firebrick were used instead of one, and 1/2-in. thick asbestos cementboard was placed between the firebrick and the reinforced concrete. A second incinerator of this type will be larger to facilitate loading. A successful feature of the installation has been the relative freedom from smoke problems.

68-0514

Pearl, D. R. What the future holds for incinerators. *American City*, 83(10):121-162, Oct. 1968.

Incineration seems to be the only practical answer to mounting refuse disposal problems in heavily urbanized parts

of our nation. Future incinerators will emphasize more effective pollution control devices, the salvaging of heat energy, continuous rather than batch feeding, and automatic residue collection. This article draws from 'A Review of the State of the Art of Modern Municipal Incineration System Equipment,' a detailed report by the author for the Public Health Service. This section probes the promising future of incineration with predictions of coming improvements in individual techniques, which together comprise an incineration system. Different types of furnaces, burners, controls, scrubbers, cyclones, bag filters, crushers, and spreaders are discussed.

68-0515

Pitney, J. P., and E. L. Erickson. Fluidized bed fly ash filter. *Journal of the Air Pollution Control Association*, 18(10):684-685, Oct. 1968.

Removal efficiencies of fly ash from air streams by a fluidized bed of solids were measured experimentally, by weight, in a 4 in. ID glass fluidization column. The effects on fly ash removal of the following variables were investigated: particle size of the bed medium, fluidization characteristics of the bed medium, time of run, bed depth, fly ash loadings of the fluidizing air, superficial velocity, and humidity of the fluidizing air. The bed media used were silica sand, agglomerated fly ash, aluminum silicate, polystyrene beads, and wax particles. Using 400-micron agglomerated fly ash particles as the bed medium, 0.5-in. beds fluidized at 0.5 ft per second resulted in 98.5 percent removal at a relative humidity of 45 percent and complete removal at a relative humidity greater than 70 percent. Using 400-micron polystyrene beads at a superficial velocity of 0.3 ft per second, resulted in removal efficiencies as high as 99.7 percent.

68-0516

Pollutionless refuse incineration. *British Chemical Engineering*, 13(12):1,653, Dec. 1968.

The Takuma system of refuse incineration is a continuous closed system which achieves complete combustion without atmospheric pollution. A unique grate design insures efficient transport of the burning refuse, and creates maximum disturbance and aeration of the furnace bed. Operation is automatic, and unit capacities can vary from 60 to almost 1,000 tons per day. Waste gases are passed to the stack via the dust-extracting equipment and a heat exchanger. A waste heat recovery system is also included. It can generate either steam or hot water for power generation and/or district heating purposes.

68-0517

Plan end to open burning in Hawaiian Islands by 1970. *Solid Wastes Management/Refuse Removal Journal*, 11(2):14, Feb. 1968.

The Waipahu refuse dump, 15 miles from Honolulu, currently burns some 300 tons of rubbish per day. It will be replaced by an incinerator by 1970, and at the same time, the current open burning will be discontinued. The principal objection to the present dump is an esthetic one, since the smoke is not only unsightly, but also deposits ashes and other debris in Waipahu or on Ewa Beach on windy days.

Incineration

68-0518

Proceedings; 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers. 354 p.

The conference was sponsored by the ASME Incinerator Division in cooperation with the Air Pollution Control Association, the American Public Works Association, the American Society of Civil Engineers, and the Incinerator Institute of America. The papers presented covered such topics as: incinerator design; air pollution control; incineration in Europe and Japan; corrosion problems; incineration of bulky wastes and packaging materials; refuse composition; incinerator waste water and residues; and incineration plant equipment. Numerous charts and illustrations accompany the text.

68-0519

Pilot studies. In Land reclamation by accelerated stabilization; first annual progress report. Los Angeles, Ralph Stone and Company, Inc., Aug. 1968. p.15-23.

Pilot plant facilities were established to demonstrate improved volume reduction. The concepts employed were underground incineration; rapid biological oxidation by controlled aeration; moisture application, heating, and natural thermophilic heat generation; improvement of odor and particulate filtration and adsorption by varying the soil cover in terms of depth, type, moisture content, and charcoal admixture; and other chemical and physical methods for accelerated degradation. Three cylinders of 24-in. diameter asphalt-dipped steel pipes were used for biological oxidation and the bottoms were sealed with a three-in. course of earth and mastic. Cylinders 1 and 2 contained air distribution piping embedded in a gravel course, while cylinder 3 was naturally aerated. There was more biochemical decomposition in Cylinder 1 than in Cylinder 2, as indicated by greater volume reduction. Because of cylinder boundary effects and excess air, the temperatures were below that desired for optimum decomposition. Cylinders 4 and 5 for underground incineration were two 55-gal steel drums, 22.5 in. in diameter and 35 in. high. Burners were installed to initiate combustion, and tubing was provided for aeration. Experimental data indicate that underground incineration of refuse is technically feasible.

68-0520

Rampacek, C. Extraction of metal and mineral values from municipal incinerator residues—a progress report. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. C-12.)

One of the major research projects in the Bureau of Mines is concerned with the metal and mineral waste that currently occur in disposing of municipal refuse. The composition and characterization of incinerator residues has been investigated, and methods are being developed for continuous mechanical separation of residues into categories of materials suitable for further metallurgical processing and refining. The most promising procedure consists of screening the residues, magnetic separation, drying and shredding, and treatment in a low-intensity wet magnetic separator. The problem of

recovering copper and tin from the iron fractions, preferably by leaching without loss of iron, still remains. Later, research will be conducted on the recovery of mineral values contained in fine ash, pulverized glass fractions, carbonaceous slimes, and table tailings.

68-0521

Rao, T. R. S., G. Gulernter, and R. H. Essenhigh. Scale up of combustion pot behavior by dimensional analysis. In Proceedings; 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers. p.232-236.

The nature of dimensionless groups characterizing combustion behavior in an incinerator was established. In particular these groups should determine the influence of scale in transposing results from the combustion pot to the incinerator. The analysis indicates that if F is the burning rate per unit area of grate, and k is an effective reactivity coefficient, then the ratio (F over k) can be expressed as a function of a minimum of four groups involving nine parameters. From inspection of these groups, it would seem that their values may well be the same in both systems for the same range of dimensional parameters. It follows from this that the scale factor involved should be unity, i.e., combustion and burning rate data obtained in a combustion pot should transpose to an incinerator bed without change. Other factors then being equal, the area burning rate can only be increased if k is increased.

68-0522

Refuse incineration. Public Cleansing, 58(9):454-455, Sept. 1968.

The reports given at a one-day symposium at Winchester, England, on matters concerning refuse incineration are discussed. Plant design, waste heat recovery, refuse constituents and calorific values as they affect plant design, and economic aspects relating to large-scale incineration, were topics of the papers delivered. Three manufacturers discussed their methods of incineration. In addition, there was some discussion of a traveling grate known as the Class 'L,' and a circular Simon-Boulger cell with a rotary stoker.

68-0523

Roberson, J. E. Bark burning methods. Tappi, 51(6):90A-98A, June 1968.

For a paper mill utilizing pine, approximately 12 percent of the entire wood supply received is bark and it must be burned. The number of shifts per week that the woodyard operates directly affects the size of the burning equipment and may influence the type selected. Modern bark-burning methods utilize traveling grate spreader stokers, suspension firing, and cyclone furnaces. Technical design guides currently in use by the three major manufacturers for these firing methods are tabulated. Each firing method is reviewed, and their pertinent operating characteristics are discussed. Several considerations are presented as a checklist to prospective purchasers of bark-burning equipment. Some of the major considerations are adequate bark-burning capacity,

properly sized bark, controlled bark flow, careful selection of burning equipment, and careful selection of furnace size.

68-0524

Rohr, F. W. Suppression of the steam plume from incinerator stacks. In *Proceedings; 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers. p.216-224.

Various methods are described by which the air pollution control system of a municipal incinerator can be designed to suppress the steam plume caused by the moisture in combustion gases. The methods include: electrostatic precipitation of water droplets from fogged air; mechanical separation of water droplets from fogged air; absorption or adsorption of water vapor; mixing of the moist gases with relatively dry, heated air; condensation of the moisture by direct contact with water or a cold surface; and scrubber exhaust reheating the gases. For a comparison of the technical feasibility of the various methods, a design ambient air temperature of 20 F was chosen for the flow diagrams and charts. Cost comparisons of systems for suppression of steam plumes at 20 F and 40 F were determined. Although the construction costs for any of the systems are higher than a basic scrubber system, the operating costs are not proportionally higher. The operating costs for the basic scrubber include the cost of water which is lost by evaporation. The system, which involves mixing with heated ambient air, can be operated at less cost than the basic scrubber system without means for vapor suppression because of reduced water costs. The cost of scrubber systems, with the means for suppression, is related to the lowest design ambient air temperatures at which the system is to be effective and to the method of dehydration of the flue gases. The costs of these systems for use at temperatures above 20 F may be comparable to wet scrubber systems in which no provision is made for suppression.

68-0525

Rousseau, H. The large plants for incineration of domestic refuse in the Paris metropolitan area. In *Proceedings; 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers. p.225-231.

The quantity and composition of refuse, handled by the T.I.R.U. (Traitement Industriel des Residus Urbains) in its four incinerator plants located around Paris, are described. All four plants are equipped with incineration furnaces and are connected to the railway system in order to send ash residue to the sanitary fill. The Ivry and Romainville plants can also prepare the resulting product for soil amendment by screening, scrap iron removal, and grinding. Of the total, three-quarters (1,200,000 tons) are incinerated, and the rest is divided equally between soil improvement and sanitary landfill. The St. Ouen and the Issy-les-Moulineaux plants are discussed in detail, as well as the Ivry plant which will shortly be opened. The St. Ouen plant includes four Volund furnaces, the boilers of which have suspended tube-nests for vaporization and superheating. After being desuperheated, the entire supply of steam is sold to the municipal heating system or to an industrial client. The furnaces of the Issy-les-Moulineaux plant use the Martin grate, repulsing the

refuse upstream in order to insure effective mixing. The dust collection system is electrostatic, has an efficiency of more than 98 percent, and extracts more than 50 tons of fly ash per day. The use of boiler power, designed for a higher heating power than is normally used today, has exceeded 75 percent with a mean evaporation of 33.8 tons per hr, i.e. a yield of 1.77 ton of steam per ton incinerated. Some electricity is utilized for the requirements of the plant itself, and the rest is sold to the French Electric Power Board. A new annual operation cost of \$2.78 per ton is expected.

68-0526

Schoenberger, R. J., and P. W. Purdom. Classification of incinerator residue. In *Proceedings; 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers. p.237-241.

In order to evaluate the environmental impact of incineration, incinerator residue was classified according to the amount of combustible material that remained after the burning process. Raw and incinerated refuse was analyzed in three fractions: a water soluble fraction—that part of the refuse or residue which can be leached by water through surface infiltration or ground water saturation; an other soluble fraction—soluble in petroleum ether; and a volatile fraction—combustible, exclusive of free carbon. In addition, the water soluble fraction was analyzed for alkalinity, hydrogen ions, nitrogen, phosphates, chlorides, sulfates, sodium, potassium, iron, and dissolved solids. It was found that although the incinerated and raw refuse resulted in approximately the same amount of dissolved solids, the character of the solutes was quite different. The raw refuse had a higher percentage of organic material, while the incinerator residue contained more inorganic salts.

68-0527

Schoenberger, R. J., and P. W. Purdom. Residue characterization according to furnace design. Presented at *American Society of Civil Engineers Environmental Engineering Conference*, Chattanooga, Tenn., May 13-17, 1968. 17 p.

A table gives data on residue from three different continuous feed incinerators. Each plant had one inclined stoker for drying and ignition, and one horizontal stoker for combustion. Two of the plants had supplemental I.D. fans, while a third relied upon natural draft. The design capacity of all three plants was similar. The data indicate that a significant difference does exist in the character of residue from incinerators. This conclusion was reached despite the fact that there is no one comprehensive way to analyze the character of incinerator residue. As a consequence, there is also some discussion of the basic tests that are used. Among them are two basic tests used in the classification of any solid waste matter, the test for volatile materials, and the test for ether soluble materials. The term 'volatile matter', as used here, describes the quantity of combustible material which remains in the residue after incineration. Other organic solvents may be substituted for ether to perform still other analyses. A table is included which indicates the tests that are recommended if a complete characterization of solid waste is to be undertaken.

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68-0528

Schoenberger, R. J., N. M. Trieff, and P. W. Purdom. Special techniques for analyzing solid waste or incinerator residue. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.242-248.

Methods were developed to determine the nitrogen, carbon, hydrogen, protein, chemically-decomposable organic (CDO), and calorific values of solid waste or incinerator residue. The chemical composition of two types of residue and unburned solid waste was determined using these methods. Carbon and hydrogen determinations were done through a combustion analysis, which is essentially a scaled-up modification of the Steyermark micro procedure. The nitrogen determination is the conventional Kjeldahl procedure. The CDO determination for oxidizable organic material is a modification of the IRGRD procedure. Calorific value was measured with a Parr Peroxide Bomb Calorimeter. The ether soluble and water soluble fractions were extracted using a Soxhlet apparatus and the designated solvent. One type of residue was obtained from a batch-feed circular furnace, and the other type from a two-stage, continuous-feed traveling grate unit. The range for a particular analysis is large. This indicates a large daily variation between samples, due to the fact that samples were taken randomly with no regard for the influence of weather, time, or season. Calorific value-percent carbon correlation coefficients were interpreted by noting that refuse is primarily carbon in the form of cellulose. Results indicate that a relationship can exist between some of the common analytical procedures, namely between carbon, hydrogen, and percent volatile, and the special techniques used to characterize the unburned portion of residue such as CDO, nitrogen, percent water soluble, and percent ether soluble.

68-0529

Schulz, J. F. Factors involved in the design of high rise chimney and chute systems. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.249-272.

Some of the building conditions of high rise construction are presented so they may be recognized and incorporated into the design of chimney systems. The natural pressure of a building is the pressure which is produced by the difference in weight between the inside and the outside air. When shaft openings are examined, it is found that the pressure at each floor is undiminished within the shaft, thus a shaft opening which has a friction loss equal to that of a floor will have more effect upon the building pressures than the floor opening. Refuse, trash, or laundry chute openings should be kept as small and as tight as possible and should be equipped with a device that prevents air from entering the chute when it is open. The effect of wind upon building pressures and chimney terminations is reviewed. When a chimney is terminated in the eddy zone it allows pollutants to be carried to the building where they may enter the living area by following the normal air flow patterns. The wet chimney and other problems may be minimized by combining the boiler chimney, the incinerator chimney and the refuse chute in a single cluster. Practices for reducing wet chimney problems are summarized. Recommendations, including diagrams, are given for: design of refuse chute and incinerator system for buildings up to 10 stories; purging of refuse chutes by heat

from the incinerator burners; leakage of chimney gas into a building; maintaining adequate temperatures in a chimney; chimney installation when a draft inducer is not required; and chimney installation in which a draft inducer is required because of the gas washer.

68-0530

Setteducato, N. M. Demonstration incinerator to have electrostatic precipitator. *Public Works*, 99(3):99-100, Mar. 1968.

The multipurpose incinerator of the City of Stamford, Connecticut, is part of a demonstration project, which is partially financed by the Public Health Service. The purpose of the grant is to develop new techniques for eliminating air pollution caused by incineration of domestic, commercial, and industrial solid wastes. The facility, with an estimated construction cost of more than \$1 million, will provide for the incineration of the area's solid wastes which, because of size or content, cannot be accepted into the main incinerator. It is estimated that a maximum of 50 automobiles per day will be converted to baling steel by the incineration of all paint, rubber, plastics, and other contaminants. Two other ignition chambers will handle 175 tons per day of oversized bulky wastes. Gases from the three ignition chambers will enter an adjacent central combustion chamber, where they will be completely consumed along with liquid wastes which are introduced by spraying. An electrostatic precipitator, having a capacity of 160,000 cu ft per minute at 600 F, removes a large percentage of the finer dust particles leaving the flue gas which is 90 to 95 percent free of pollutants. The ash and residue will be disposed of in an adjacent landfill.

68-0531

Shuster, W. W., and J. S. Gilbert. Partial combustion of solid organic wastes. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint C-4.)

The possibilities of reacting certain organic components of solid wastes with limited quantities of oxygen to reform them into simpler organic compounds of economic interest was investigated. Efforts were directed to the design, construction, and calibration of equipment used for the study. Finely divided paper and 'Orgro,' a dried sewage sludge, were fed to the reactor. It was found that the products obtained from 'Orgro' appeared to be more numerous and more complex than those from paper. Preparative gas chromatography and infrared spectroscopy methods were found satisfactory for identifying the products. Runs were made using various ratios of air to nitrogen in the reacting gas. The products included carbon dioxide, methanol, propylene, ethylene, methane, butane, and butene.

68-0532

Silva, A. Mechanical draft fans for the modern incinerator. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.273-277.

The performance characteristics of forced and induced draft fans are presented with special reference to incinerator

applications. In order to make fan requirements valid, the lb of air or gas per hr, and/or the density in lb per cu ft, and the elevation in feet above or below sea level must be known. The ideal forced draft fan arrangement is either single or double inlet. Variable inlet vanes should be used for volume control, and since very few plants can offer completely dust-free air even from outside the plant, vanes with all bearings and operating mechanisms outside the airstream should be used. This is especially essential if fans are pulling air from in-plant locations such as the ash pits or tunnels, storage pit, or even the operating floor. The radial tip fan is the best choice for an induced draft system, when the gas to be handled is not clean. Even if a mechanical collector is used, quantities of fly ash will still get to the fan. Where electrostatic precipitators are to be used, the obvious choice would be an airfoil-bladed fan. Radial tip, backward inclined flat blade, and airfoil wheels can be good choices when a wet scrubber is used. Special blading and fan construction for use under corrosive conditions are discussed.

68-0533

Smith, R. A., J. Hornyak, and A. A. Carotti. Analysis of stack effluent from municipal incinerators. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint C-8.)

The objectives of the current program are to evaluate seasonal variations in the refuse, stack emissions, and quench water from the municipal incinerator in Long Island, New York, and four different types of incinerators in the New York area. Another objective is to identify and quantify specific inorganic and organic compounds present in the stack effluent. Equipment for the collection of representative samples of stack effluent was designed, and its high efficiency as a trapping system was experimentally demonstrated. Results of a partial analysis, using gas chromatography and infrared spectrophotometry, indicated that water recovered from the traps contained acetone, acetaldehyde, methanol, ethanol, methylethyl ketone, high molecular weight alcohols and benzene. The major components of gas samples were nitrogen, oxygen, carbon dioxide, and carbon monoxide.

68-0534

Smith, R. D. Feasibility study of applying jet-engine technology to refuse incineration. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint C-3.)

It has been shown that incinerators using jet engine technology are feasible and can reduce incineration costs by providing saleable products such as electric power and steam. Each incinerator consumes approximately 400 tons of refuse per day. If all a city's refuse were converted to electric power, it would supply approximately 10 percent of the city's needs. Refuse is burned at elevated pressure (90 to 180 psia), and work is extracted directly from the hot gas by expansion through a turbine; the heat remaining in the gas after expansion is converted to steam in a waste heat boiler. The hot gas is cleaned at an elevated pressure immediately downstream of the combustion chamber to preclude particulate matter from entering the turbine. Pressurized air is supplied to the combustion chamber by the compressor, a

jet engine (gas turbine); the turbine of the engine extracts work from the hot gas to drive the compressor, in addition to driving an electric generator.

68-0535

Stephenson, J. W. Incinerator design with operator in mind. In Proceedings: 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers. p.287-294.

Since the average designing engineer cannot acquire sufficient operating experience to become familiar with all the problems faced by plant personnel, details considered minor by the designer may, if not properly treated, become major problems or inconveniences in plant operation or maintenance. Suggestions by leading municipal incinerator plant operators, based on many years' experience, are presented for consideration by designers. Operators generally feel plants should be designed with firm capacity adequate to handle the daily refuse load. Plant structures and facilities should be designed and sized for 24-hr operation, even though planned operation may be only one or two shifts. Refuse receiving, storage, and handling facilities should receive particular attention. The designer or a qualified representative should be on the job throughout the construction and start-up period to supervise construction, initial operation, and tests. Specifications should be clear in placing responsibility for adjusting, testing, and initial operation of all equipment and the entire plant. Attractive surroundings and adequate comfortable facilities are important in attracting and holding competent personnel. Operators are unanimous in wanting a truck scale at all plants. Well-lighted and ventilated, enclosed, tipping areas are preferred, and the need for an adequately sized storage pit with sprays for fire protection, dust control, and rugged cranes is emphasized. Most comments related to operation and maintenance of incinerators mention air pollution control design. Chimney design, forced draft problems, instrumentation and controls, waste supply and drainage, heating and ventilating, electrical equipment, and facilities for maintenance are also discussed.

68-0536

Sternitzke, R. F., and M. Dvirka. Temperatures and air distributions in large rectangular incinerator furnaces. In Proceedings: 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers. p.295-302.

Proper design and operation of municipal incinerators with combustion and excess air delivered in correct quantities, at the right place and at the right time, will result in controlled optimum operating furnace temperatures and reduced refractory maintenance cost by virtue of limited slagging reduced stoker maintenance costs, and considerable reductions in potential particulate emissions. Basic theories of furnace design and their application in modern refuse burning furnaces are discussed with some preliminary and partial test data (observations based on experience in the operation of various types of municipal incinerators). While many designers assume an average operating temperature range of 1,600 to 1,800 F, some specifications stipulate a temperature range of 2,200 to 2,300 F as a safe upper limit of the refractory lining. The characteristics of the current

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refractory enclosures, and the intimate supporting structures indicate that temperatures in this range, over a prolonged period of time, will cause some deterioration and shorten the life of the refractories. Temperatures in excess of 1,800 F will cause excessive slagging due to the presence of low fusion point fly ash and the diversity of chemical composition of the waste materials, such as plastics and glass. The optimum safe performance of a given furnace is usually obtained by providing plus or minus 70 percent of total air as overfire air, and up to plus or minus 60 percent of total air as underfire air. Recommendations are made for the design of combustion air systems.

68-0507

Stickley, J. D. Instrumentation systems for municipal refuse incinerators. In Proceedings; 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.303-308.

The basic control systems used in modern incinerators are outlined. An incinerator must be controlled so that it will effect complete combustion of refuse and prevent the release to the atmosphere of offensive gases and smoke. Instrumentation systems help the operator accomplish these purposes under varying fuel conditions at a minimum cost per ton of refuse burned. In addition, they help to keep the incinerator and associated equipment from being damaged by high and/or rapidly fluctuating temperatures. In order to assure an adequate flow of underfire air, it is desirable that the actual air flow be controlled. To insure complete combustion of all volatile matter, the furnace outlet temperature is usually maintained in the 1,700 to 1,900 F range. The temperature control system does this by continually varying the total amount of air that is delivered to the furnace. As a result, a draft control system is necessary to maintain the proper pressure in the furnace. In addition, to prevent damage to the dust collector and the induced draft fan, the hot gases from the furnace must be cooled to approximately 650 F. In some of the modern incinerators, a control system for multiple unit cyclone collectors is necessary. Pressure, temperature, and flow indication instruments, as well as smoke density monitors and alarms, should be installed. The sophisticated techniques of ratio and cascade control of interrelated variables are examined as tools for more effective operation of incinerators. Schematic drawings for the control systems are provided.

68-0538

The switching on of a modern refuse plant at Sileby, Leics. Machinery Market, (3528):62, 66, June 27, 1968.

Barrow-on-Soar Rural District Council, Leicestershire, has put into operation a £-250,000 refuse incineration plant to handle the rubbish collected from its district of 65,000 people. The plant will be capable of dealing with a maximum 110 tons of domestic refuse per 8-hr day. Burning capacities are based on the assumption that 40 percent by weight of incoming refuse will be extracted in the form of screenings and salvage. Collection vehicles discharge their loads into the reception hopper, which has a capacity of 140 cu yd and is fitted to an extraction plant to prevent dust nuisances. A rotary screen removes fine materials from the refuse before it reaches the salvage section. The two steel-cased incinerator units each consist of four cells with a semimechanical trough

grate design. These have a rear combustion chamber and provision for hand-feeding bulky articles or condemned carcasses. Provision is made to quench the clinker before it is deposited in the storage yard. Gases pass through a water-trap type grit arrester, reinforced with a spray system, on the way to the 175-ft chimney.

68-0539

Tanzer, E. K. Pneumatic conveying for incineration of paper trim. In Proceedings; 1968 National Incinerator Conference, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.309-317.

Design parameters were developed for a pneumatic system that would convey paper trimmings and shredded resins from multiple sources to boilers 1,400 ft away. The trim is collected at numerous winders and carried through several ducts to a large booster fan which then sends it to a cyclone separator where it accumulates. The air which leaves the cyclone is withdrawn and washed by a wet, centrifugal, blower-scrubber. Meanwhile, the paper from the bottom of the cyclone is withdrawn and washed by two high-pressure blowers and then delivered through a 6-in pipeline to a central powerhouse. The system has been operating successfully for three years, so the velocity needed in the pipeline, the size of the blowers, the needed horsepower, and the proper air-to-paper ratio have all been determined. In another project, a large multi-pipe conveyance system to handle scrap from various photographic finishing operations was installed. Material is shredded and then conveyed to a horizontal automatic baler. Another part of the system involves a 1,000-ft conveyor line from the production area to the plant boilers. Both systems have been designed to handle 200 lb of paper per minute. Schematic diagrams of the disposal system for waste paper trim, and of the scrap paper disposal system with balers are presented.

68-0540

Trainor, H. W. Special boilers for waste fuels. Power Engineering, 72(2):42-44, Feb. 1968.

The author states that package boilers are not suitable for burning pulp mill wastes because of differences in the burning properties of the two primary wastes, black liquor and bark, and because of the necessity of recovering inorganic salts from the black liquor. Using a Kraft mill as an example, the recovery of the salts from the pulping process is described. The unit, consisting of furnace, superheater, boiler bank, integral economizer, direct contact evaporator, electrostatic precipitator, and auxiliaries, produces heat by burning the organic constituents of the liquor, while the inorganic constituents are reduced to sodium sulfide and then causticized, producing sodium hydroxide. These chemicals are then reused in the pulping process. Even the specially designed furnaces experience loss of 15 to 20 percent of the inorganic dry solids in the flue gases. Bark is usually burned in baffleless boilers with low gas velocities. Some mills have tried to adapt industrial-type boilers to bark-burning, but because of the baffles and higher gas velocities, tube erosion has been severe. It is virtually impossible for a single boiler unit to burn both fuels as efficiently or economically as separate units, and package boilers appear unsuitable for both purposes. The loss in chemicals alone would offset any initial savings.

68-0541

Tucker, M. G., and T. A. Hegdahl. Comprehensive testing of municipal solid waste incinerators. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint C-14.)

The Solid Wastes Program has scheduled a series of tests on incinerators of various designs including: continuous and batch-fed 'standard' refractory-walled furnaces with differing grate characteristics, 'water-walled' furnaces, rotary kiln furnaces, teepee burners, and pit incinerators. The results, to be obtained while charging at 100, 75, and 50 percent of the rated design capacity of the units, will be monitored. Some factors to be studied in detail during these tests are: composition, rate, and method of solid waste charging; combustion performance characteristics; instrumentation and controls; effluent characteristics; economics; working conditions; effluent and residue disposal; and maintenance and sanitation.

68-0542

Utah State Division of Health. Weber County incinerator environmental evaluation study. U.S. Department of Health, Education, and Welfare, 1968.

The purpose of the planned study is twofold: to provide agencies with an evaluation of the facility and to provide the Solid Waste Program with detailed data on specific aspects of the incinerator. Of primary interest in the evaluation of the plant are: the efficiency of the incinerator; the effects of the operation on its environment as indicated by the quality of the stack emissions, and the acceptability of the disposal of the solid residue and liquid effluent; the acceptability of the work environment; the economics of maintenance and operation; and the effectiveness and efficiency of the plant. Of additional interest are: the effects of the various system components; the relation between the influent solid wastes and the effluents; evaluation of specific plant design; and testing sampling techniques. The procedures used during the course of the study are presented. In addition, in an effort to improve our understanding of municipal incineration, a series of detailed evaluation studies has been planned. Of major importance to the studies is a detailed analysis of the solid waste influent and the gaseous, liquid, and solid effluents of the incinerator. A brief outline of analytical techniques for analyzing combustible and putrescible matter, especially with chemical techniques from the Drexel Institute of Technology, is appended.

68-0543

Wakabayashi, T. Utilization of heat energy generated by incinerators. *Energy and Pollution Control*, 20(6):9-15, June 1968.

Continuous and automatic incinerators are examined as a feasible source of hot water. The following conditions were assumed: A, B, C, and D cities have populations of 50,000, 100,000, 150,000 and 200,000 respectively; the total length of the main hot water line from the incinerator to the area supplied is 6 km; the production of refuse is 600 g per capita per day; the average low grade calorific value is 850 kcal per kg; and there are three workers in three shifts. For four cities, the amount of refuse to be collected, its calorific value, the

costs of an incinerator with a boiler for hot water and a sinking fund for these facilities were calculated. Also, the costs of labor, maintenance, auxiliary fuel, and refuse collection were obtained. The costs for hot water mains and the production of hot water were also calculated. The latter varied from 315 to 280 yen per ton of hot water. Finally, the difference between the sinking fund for facilities with a boiler and those without one was figured as one of the criteria for the determination of the price of hot water. It was concluded that the quality of the refuse must be improved before it is possible to effectively use the heat energy from incinerators. (Text in Japanese)

68-0544

Watkins, A. M. New incinerators burn the smoke, too. *Popular Science*, 192(2):149-151, Feb. 1968.

Smokeless and odorless incinerators appear to be the solution to many household trash and air pollution problems. These compact incinerators burn 75 to 80 percent of the trash and garbage in the average home. All refuse is burnt to a fine white ash. The key to the operation is a second stage or afterburner that burns any unburned particles that get past the first set of flames. The incinerators can handle loads from 1½ to 2 bushels. The average size is around 22 by 33 inches. They are engineered with numerous safety features and need little maintenance, and they operate on any kind of gas. Their average price is \$165. Class A or Class L chimneys are prerequisite for incinerator operations. Illustrations of the incinerators are included.

68-0545

Woodruff, P. H., and G. P. Larson. Combustion profile of a grate-rotary kiln incinerator. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8 1968. American Society of Mechanical Engineers, p.327-336.

A study was made of a 300 ton per day grate-rotary kiln municipal incinerator that was a subject of public complaint because of fly ash and odors. Sampling data were obtained at the end of the rotary kiln, in the secondary combustion chamber, just ahead of the spray chambers, and in the stack. Samples were also taken at varying elevations at each point in the combustion process. Data was obtained on gas temperatures, particulate loading, hydrocarbons, oxygen, carbon dioxide and carbon monoxide. Sampling data have been correlated with refuse loading and general operation characteristics of the incinerator to produce typical operating profiles. The profiles illustrate gas flow and combustion characteristics of materials as they are burned in this type of incinerator. Recommendations were made for modification of the combustion air supply and gas mixing systems. The incinerator should be operated on a 7-day basis. The floor operator should make the necessary adjustments to keep the temperature above 1,500 F. The amount of underfire air presently being introduced should be reduced, and a portion of this air diverted over the fire bed in the primary chamber for the purpose of reducing the amounts of suspended fly ash. The feasibility of reducing infiltrated air into the ash pit through the diversion gate assembly should be investigated. An engineering study on the feasibility of installing appropriate baffles or checkerwork across the secondary combustion chamber, at the point after the gases have passed over the existing bridge wall, would be the next step.

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68-0546

Zinn, R. L., and W. R. Niessen. Commercial incinerator design criteria. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.337-347.

Upgrading the capabilities of commercial and industrial incinerators is necessary in view of projected trends in packaging materials which herald increased amounts of plastics, metal foils, and glass. An incineration system must be able to handle a wide variety of wastes, and be able to consume refuse of high moisture content. Incineration devices must include adequate air pollution control systems. High combustion efficiency must be realized, and the ash residue should be easy to handle.

Rapid burning is required in order to provide a high disposal capacity per square foot of floor area. In order to provide for safety, operator comfort, and to reduce oxidative corrosion, external surface temperatures should be minimal. The incineration characteristics of important packaging materials are reviewed and packaging trends are projected through 1975. The following specific design principles were developed: a burner appears necessary in the primary chamber and in the secondary chamber; air control is necessary; an efficient, integrated air pollution control device is necessary; gratelessness is highly desirable if coupled with agitation which is also highly desirable; and continuous flow of refuse and ash is needed. To review the economics of incinerator operation and in order to have a cost framework for the designing purposes, a simple mathematical model of net incinerator costs was prepared. Below about 200 lb per hr, almost any incinerator operation is uneconomical.

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68-0547

Andt, K. H. 72 years of waste incineration in Hamburg. *Elektrizitätswirtschaft*, 67(18):543-547, Aug. 1968.

The first plans for the construction of a waste incinerator plant in Hamburg, West Germany, date back to the year 1893. Its construction was prompted by an outbreak of a cholera epidemic the year before. This plant operated until 1924. In the years 1912 and 1913, two further waste incinerator plants began operation. In the year 1931, the plant in the "Borsistraße" was opened with a daily capacity of 300 tons. In 1956 it was modernized. The installation of five furnaces now permits it to operate continuously. It is capable of incinerating 285,000 tons (about 1.3 million cu m) of domestic wastes. The plant has a storage bunker with a volume of 8,500 cu m. The longitudinal combustion chamber is equipped with a Von Roll grate which is divided into a predrying and combustion grate. The temperature in the combustion chamber is kept within certain limits, because at more than 1,000 C the slag sinters, and below 800 C odors are emitted. Oil burners are installed as auxiliary burners and to ignite the furnace. The heat which arises is used for the production of steam. The flue gases are cleaned by electrofilters. The fly ash is sucked through pipes into a collecting container, from which it is pressed into silos. With 14 percent by weight, the slag forms the highest portion of the residues (scrap 3% and fly ash 6% by weight). It is used in the construction of roads. Hamburg has about 1.85 million

inhabitants and an annual accumulation of waste of more than 3 million cu m. The increase in waste in the last year was 6.1 percent. The construction of a new plant in 1972 has also been planned. An incinerator for industrial wastes is being erected close to the existing domestic waste incinerator. (Text in German)

68-0548

Association for erection of a common incinerator in the Niederrhein. *Brennstoff-Wärme-Kraft*, 20(9):408, Sept. 1968.

The association was formed on April 2, 1968 by eight cities (Duisburg, Oberhausen, Dinslaken, Rheinhausen, Walsum, Moers, Homburg and Voerde) in the Niederrhein area, West Germany. The cooperation of these cities has many advantages. It decreases the investment costs of the incinerator from 53.2 million to about 38 million DM. Additional costs are saved by using fewer operating personnel. The association will also be concerned with the elimination of the residues from incineration. It plans to supplement the plant by a sanitary landfill for dumping the ash. The eight cities have a total population of 1,016,550. The annual accumulation of combustible wastes will total 295,830 tons, of which 200,000 tons will be domestic refuse (i.e., 180 kg per inhabitant). The heating value fluctuates between 800 and 2,500 kcal per kg. Unfortunately the incineration of industrial wastes is not included in this plan. This will be the task of the individual companies. The waste incinerator plant will consist of three furnaces with a total capacity of 50 tons per day and this plant can work continuously in three shifts. Steam production will amount to 65 tons per hr at 40 atm and 300 C. An electrofilter will clean the flue gases. Cost calculations indicated 39.4 million DM for investment costs, 6.13 million DM per year incineration costs, and 648,000 DM per yr for personnel costs. The specific incineration costs will be 19.20 DM per ton of waste without heat utilization, and 12.60 per ton of waste with heat utilization. (Text in German)

68-0549

Bachl, H. The importance of remote heat supply plants, incinerators, and offpeak electric heating systems for keeping the air clean, demonstrated by the example of Munich. *Staub Reinhaltung der Luft*, 28(2):65-71, Feb. 1968.

The air pollution problems stemming from remote heating plants and incinerators are the main subjects discussed, but some information on waste disposal in the City of Munich is given along with a graph. Munich's two incinerators are located north and south of the city (the latter is still under construction), and they deliver heat to an attached remote heat supply plant. The incinerators burn almost all the domestic wastes which until recently were dumped in the outskirts of the city or were shipped to the North Sea and dumped there. However, only a few disposal sites are left which are not potentially dangerous for groundwater. Thus the incineration of wastes has become more and more necessary, in spite of protests that it might cause a considerable increase in air pollution. For economic reasons the incinerators had to be erected within the city. This reduced transport costs. Domestic wastes pose considerable problems when incinerated. A dozen such domestic waste

incinerators pollute the air of New York City to an alarming degree, despite the prevailing winds from the sea. The U.S. Secretary of the Interior visited the Munich incinerators 2 years ago and found them exemplary. A graph shows the amounts of waste which will accumulate within the next few years. The graph also illustrates the amount of the wastes which can be incinerated. After the second incinerator in the south of the city is in operation, the entire domestic wastes of Munich can be eliminated by incineration. The incinerators will supply 5 to 8 percent of the power required by the city. (Text in German)

68-0550

Bauer, H., L. Michna, and G.L. Geer. Additional district heating from the extension of the Stuttgart refuse incinerating plant. *Elektrizitätswirtschaft*, 68(25):806-811, Dec. 1968.

The increase of the amount of refuse, along with the increase of the heating value of refuse in the City of Stuttgart, made the installation of a third incinerator in the Stuttgart-Muenster incineration plant necessary. To be able to use all the experience gained with the first two incinerators, a design similar to the first two incinerators was chosen. The incinerator has two separate combustion chambers for the incineration of refuse and the burning of oil. The flue gases from the two combustion chambers are conducted separately to a transverse flue where they are united. An electrostatic precipitator is installed in the furnace. The cleaned flue gases leave through a 180 m high stack. In order to reduce the dust content of the flue gas to the legally required 150 mg per cu m, the electrostatic precipitator has been designed for a collection efficiency of more than 98 percent. As with the two predecessors, a roller grate with six rollers was selected. The refuse combustion chamber has been designed for a maximum heating value of 2,500 kcal per kg refuse, at the full capacity of 20 tons per hr. A wet slagging facility is attached to the incinerator. The boiler has a capacity of 125 tons of steam per hr at a pressure of 66 atm and a hot steam temperature of 525 C. (Text in German)

68-0551

Baurich, G. Development of furnaces for sludge incineration. *Wasserwirtschaft-Wassertechnik*, 18(5):146-150, May 1968.

Three furnaces are described which are suited to incinerate sludges. The first is a multistoried unit which has a conically shaped helix that runs along the inside from the top to the bottom. With this furnace the sludge is first dehydrated to a water content between 70 and 75 percent by weight. It is then transported down the center of the furnace along the helix and subjected to drying heat along the way. Since the sludge has a low calorific value it is necessary to use additional burners to fully consume the sludge. The second furnace is a turbulent layer type which utilizes a fluidized bed of quartz sand. This unit includes a rotating vacuum filter which is used to lower the water content of the sludge prior to incineration. This process features high incineration temperatures in the range of 1,150 to 1,200 C. The third type of furnace dries and consumes the waste in a rotating sheet steel tube which is heated from the outside. The design of

this last furnace is such that the sludge can be fed parallel or counter to the flow of combustion gases. There are also provisions for injecting additional air into the combustion zone. Illustrations of all three furnaces are given. (Text in German)

68-0552

Bellendorf, F. Operating experience with a double rotating drum for the incineration of industrial wastes at the Chemische Werke Hules AG. *Brennstoff-Waerme-Kraft*, 20(9):414-419, Sept. 1968.

The double rotary drum furnace, which has been in operation at the chemical plant, Hules AG, since August 1966, was designed with a capacity of 2,400 kg per hr at a mean heating value of 5,000 kcal per kg. All combustible wastes accumulating in the plant, from paper to plastic material and waste oil, are burned in the furnace. The air inlet for the first drum is 2.8 m, that of the second drum 3.5 m. Both drums together have a length of 15 m. The numbers of revolutions per hr of the two drums is adjustable, but the first is kept at between 7.5 and 30 revolutions per hr and the second between 6 to 30 revolutions per hr. The second drum can rotate to the left or to the right. The flue gas temperature, at its end, is about 800 to 1,000 C. A cooled pipe grate has been installed behind the second drum. To heat up the furnace, an oil burner is used. The furnace is also equipped with an afterburning chamber with a square cross section of 2.5 to 4.5 m. Waste oil can be burnt here if the flue gas does not reach the requisite 800 C at the end of the drum. The boiler has a capacity of 12.5 tons per hr at 25 atm and 380 C. After 12,300 operating hr, it can be said that the plant operates quite satisfactorily. The plant has had to be switched off 29 times for repair work. The cooled loading chute has caused the most trouble. The investment costs of the plant amounted to 3,300,000 DM without a chimney, which existed already, but it includes the cyclones, storage room, access roads, and pipelines. (Text in German)

68-0553

Boese, R. West European incinerators are better than those of the U.S. *Energie*, 20(7/8):207, July-Aug. 1968.

Although the per capita accumulation of waste in the United States is higher than in Western Europe, the U.S. techniques are not as well developed. In Western Europe, for example, particulate emissions averaged 0.7 kg per ton of incinerated refuse, while the U.S. average was 5.5 kg per ton. The number of working hr per ton of incinerated waste in Western Europe amounts to 62 to 72 percent of those spent in the United States. The legal requirements concerning noise and dust emission are also stricter in Europe. Delivery of the wastes to the incinerator involves, in Europe, only 3.5 percent of the total costs of an incinerator, whereas it amounts to 4.9 percent in the United States. Electronic devices are employed in Europe to determine weight; electromechanic scales are used in the United States. In Europe, the storage rooms are tightly sealed off from the rest of the plant to avoid dust penetration, but in the U.S., no such measures are taken. The European incinerators are jacketed by solid sheet steel walls with only small inspection windows, since no stoking is required with the mechanical grates used. Water curtains are rarely used in the United States, although they save the expenditure of enormous sums

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on fireproof lining. In Europe, the use of waste gases for remote heating or the generation of electric power is also widespread. (Text in German)

68-0554

Brandt, H., and H. Heer. Particular dedusting problems in refuse incineration plants. *Vereinigung der Grosskessel-Besitzer*, 48(2):118-126, Apr. 1968.

The dust emission from incinerator plants has been limited by law to 200 mg per cu m for plants with a capacity of up to 20 tons per day, and limited to 150 mg per cu m for plants with a daily capacity of more than 20 tons per day. There is also a regulation which requires that the smoke from incinerators must be lighter in color than value no. 2 on the Ringelmann chart. Flue gases and dust must be subjected to a minimum temperature of 800 C to make them sterile and free of odors. Flue gases must pass through chimneys of certain minimum height. Dedusters and electrofilters cannot withstand temperatures of 800 C and more, so in practice, it is necessary to cool the waste gases. This can be done in long unprotected waste gas channels made of steel (for smaller plants only) or in waste gas boilers by injecting water or cold air. With the latter two methods the volume of the waste gas is considerably increased. A cooling system which does not inject water or air is actually more desirable. For example, waste gases can be cooled to about 750 C by exposing them to unprocessed wastes, and then cooled to 400 C by using the extra heat. Incinerator plants with energy production are more demanding as far as dedusters are concerned. The combination of incinerator plants with auxiliary oil or coal burners affects the dedusting devices in varying degrees. Mechanical dedusting devices and electrofilters are described. The heterogeneous composition of the waste makes it necessary that the short term dedusters withstand temperature increases of 50 C without damage. (Text in German)

68-0555

Braun, R. How completely shall refuse be incinerated? *Brennstoff-Waerme-Kraft*, 20(9):409-411, Sept. 1968.

To answer the question, how completely refuse shall be incinerated, three points must be taken into consideration: what is necessary to permit efficient heat utilization; how are costs affected by transporting residues to dump sites; and what are the consequences of dumping such residues? As far as the first point is concerned, the most effective incineration is determined by experience. As to the second, a somewhat lower or higher percentage of incineration residues has hardly any effect on the costs of transportation. The last point is important. Dumping of slag and ash can lead to two types of hazards: spoilage of the groundwater, and emission. The content of biologically decomposable, unburnt substances in the incineration residues must be determined. It must also be determined how high this content may be without causing hazardous conditions. A new method, developed by G. Rolle and R. Orsanic, determines the carbon bound to decomposable organic substance. A table lists some of the results of slag and ash samples, taken directly from incinerators or from dump sites. The amount of carbon bound to organic substances, which are decomposable by microorganisms, was found to lie between 1.2 and 11

percent. Based on the few tests made, Rolle concludes that a carbon content of 2.5 percent plus or minus 1 percent (dry substance) in the decomposable organic substance is a safe criterium. Considerable variations in the quality of the slag from the same plant have been found. (Text in German)

68-0556

Burning for good riddance. *Chemical Week*, 102(20):59-60, May 18, 1968.

Bayer's \$4.5-million incineration plant can take a yearly throughput of 40,000 metric tons of difficult-to-dispose-of wastes from the production of 10,000 chemicals in the Leverkusen, West Germany, works. The operating cost is \$20 to \$25 per metric ton, an increase over the former cost of \$3 to \$4 per metric ton for disposal by burial. Steam recovery amounts to 25 metric tons per hr. Only about 10 percent of the original volume of solid and liquid waste material is left after incineration. The system complies with five stringent control requirements set by local authorities. Mixing solid and liquid wastes has given the best incineration results in terms of volume reduction and economy of operation. Solid wastes are collected at 300 places in the complex and hauled to the storage bunker where a grab crane picks wastes from three tanks in rotation. This results in the maintenance of a fairly constant heating value. A dispensing sluice sends the solid matter to a rotary kiln, where it stays for 30 to 60 minutes.

68-0557

Debatable points on incineration. *Public Cleansing*, 58(9):471-474, Sept. 1968.

Regional schemes for refuse disposal were discussed at a meeting on refuse disposal in Bolton, England. In modern incinerators, tumbling the refuse is not considered necessary. The possibility of burning sewage sludge with refuse is a problem, since sludge is difficult to burn. Other problems of interest to the participants were clinker, steam production from refuse, and the conditions necessary to bring incineration to approximately the cost level of tipping.

68-0558

Diamant, R. M. E. Economics of refuse incineration. *Air Conditioning, Heating, and Ventilating*, 65(9):18, Sept. 1968.

The grate temperature in refuse incinerators is far lower than in either coal or oil-fired installations (about 1,830 F). The large quantity of slag produced (about 15% in volume of the refuse fed into the furnace) carried away a large quantity of sensible heat. The efficiencies of refuse incinerators are low, and the output of heat per unit size is also rather low, indicating that the plant must be larger than other heating plants. When refuse incinerators are used for district heating, it is best for them to supply the base load, with peak loads carried by oil or coal-fired furnaces, exemplified by the municipal heating system in Paris. It is not possible to make the sale of heat pay for the operating costs of a refuse incineration plant. In every plant built so far, operating costs have been subsidized by the authority wishing to dispose of its refuse.

68-0559

Diamant, R. M. E. Refuse burning for district heating. *Air Conditioning, Heating, and Ventilating*, 65(8):18, Aug. 1968.

The use of conventional oil or coal-fired furnaces for refuse incineration by mixing a quantity of refuse with conventional fuel, has met with unfavorable results. It has been found that the refuse lowered the combustion efficiency of the oil. In addition, it was not possible to fully utilize the heat that was available in the refuse. As a consequence, specially designed furnaces are recommended. Other drawbacks associated with conventional furnaces are the extra expenses for handling the refuse and ash produced, as well as increased maintenance and plant costs. The difficulties of using refuse as fuel are: the material contains up to 40 percent water; it has variable size, moisture content and calorific value; it has an average density of only 18 to 19 lb per cu ft varying with different components; and it is made up of very soft and very hard components. It is therefore necessary to design furnaces for refuse incineration so that the fuel is properly dried before combustion, and so that it is turned and agitated for complete combustion. The following types of furnaces are available: fixed grate, chain grate without mixing action, and chain grate stokers with mixing actions systems.

68-0560

Diamant, R. M. E. Refuse incineration for urban heating systems. *Air Conditioning, Heating, and Ventilating*, 65(6):21, June 1968.

Most European countries are attempting to use the calorific content of waste materials for district heating purposes. Combustion reduces the refuse to about 10 to 20 percent in volume. The residue produced is completely inorganic and makes a hard core that can be used as a building material. Use of small refuse incinerators, having capacities of less than 9,000 tons per year, is generally a more expensive process than removal by controlled landfill, as it is impractical to make use of the heat produced. In Germany, costs are said to exceed those of controlled landfill by about 50 percent. Very large incinerators, making full use of the heat produced, are more economical. It is estimated that the cost of burning refuse in some large incinerators, using heat to generate electricity, can run as little as 60 to 70 cents per capita per year. The trend is for these costs to drop even further, as the calorific value of refuse rises and the size of plants increase.

68-0561

Diamant, R. M. E. Refuse incineration for urban heating systems. *Air Conditioning, Heating, and Ventilating*, 65(7):6, July 1968.

The nature and calorific value of refuse differs according to the country or town from which it is obtained. Its composition has changed significantly during the last 30 years, with the tendency showing an increase in calorific value. In Switzerland, it is estimated that the average calorific value of refuse has doubled during the last 15 years. An analysis of a Danish town's refuse contribution to the calorific value is given, and the nature of refuse in various countries is compared. The calorific value of refuse in the United Kingdom is much higher than that in most other countries, since the refuse contains a large quantity of partly

burned coal from open fireplaces. Calorific values in Sweden and the United States are around 3,300 to 3,500 Btu per lb.

68-0562

Eberhardt, H., and W. Mayer. Experiences with refuse incineration in Europe. Prevention of air and water pollution, operation of refuse incineration plants combined with steam boilers, design and planning. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.73-86.

European steam generators with refuse firing must meet a number of stringent legal requirements for air and water pollution control. Emission limits are tabulated. Flue dust collectors have over 98 percent efficiency. Furnace and boiler design are considered in detail. The most economical solution for cooling of flue gases with a temperature of 800 to 1,100 C for medium-sized and larger refuse incinerator units consists of a series-connected steam generator. To obtain the most economical plant for given local conditions, it is necessary to determine the size of the firing chamber. It is shown in diagram form that incinerating the maximum volume of refuse at a maximum heating value is not economically justified. Corrosion of boiler and superheater tubes is largely prevented by maintaining oxidizing conditions in critical areas. Leaching tests of raw refuse, composted refuse, and incinerator residue show less ground water contamination from residue. Problems in planning and design of the Mannheim incinerator are detailed. Special recommendations are made concerning reliable operation of refuse bunkers, as well as the management of refuse delivery.

68-0563

Ebert, F. H. Incineration of refuse with heat utilization. *Elektrizitaetswirtschaft*, 67(18):528-535, Aug. 1968.

Since 1964 a number of incinerators have been put into operation in West Germany. Statistics which cover all operating incinerators, as well as those under construction, show that all larger incinerators utilize waste heat. A diagram illustrates the development of waste incineration with heat utilization since 1960. At present, the refuse produced by about 75 million people, is incinerated. There are various types of incinerators with heat utilization. There are those where only wastes are incinerated such as the Volund system, the Von Roll incinerator etc. Then there are the boilers heated with wastes and conventional fuels such as in the plants of Essen-Karnap, Stuttgart-Muenster, and Munich-North. And finally there are special types of incinerators such as the one of Munich-South. Here separate furnaces have been installed for the incineration of wastes and the conventional fuels, but they are connected in tandem for the production of steam. (Text in German)

68-0564

Edmonton incineration plant. *Public Cleansing*, 58(4):200-202, Apr. 1968.

Construction of the first of the new incineration plants at Edmonton, in the London Borough of Enfield, is under way on a 27 1/2 acre site which was formerly used as a sewage sludge drying bed. The refuse will be unloaded under cover

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from the collection vehicles into storage bunkers which will have a capacity of 22,875 cu yd. Two, overhead, travelling, 8-cu-yd grabs will feed 1,330 tons per 24-hr day, 7 days per week into a set of five rotary grate incinerators. The heat from the incinerators will be used to raise steam in boilers mounted above the moving grates. The steam will drive four main turbines and the output of 27 megawatts will be fed into the Electricity Board's distribution system. Residual material such as ash and clinker will be separated to provide another source of income. The incinerator gases, having been cooled while passing through the boilers, will flow into a row of five electrostatic precipitators, which will limit stack emission to 0.05 grain per cu ft. The plant will have a 328-ft reinforced concrete chimney. The total estimated cost of the plant is £9,826,129.

68-0565

The effects of variations in the composition of refuse on some incinerator design parameters. *Brennstoff-Waerme-Kraft*, 20(9):428-429, Sept. 1968.

Any planning of an efficiently operating incinerator must take into account the influence of daily, monthly, and annual fluctuations of the chemical composition of wastes and their calorific values. To determine how much the composition of the waste may change, and what effects these changes will have on some of the design parameters, the equation $H_{sub O} = 141 (C) + 619 (H/8)$ is used. The values were varied as follows: $H_{sub O}$ from 2,225 to 4,450 kcal per kg, C from 24 to 40.5 percent, H from 3.5 to 7.5 percent, O from 20 to 30 percent, H_2 from 30 to 11 percent, noncombustible material from 22.5 to 11 percent, and the C/H ratio from 24 to 10.8. A diagram plotting the heating value vs. the C/H ratio shows that increases in the heating value depend on the increasing contents of free hydrogen. Moreover, the combustion products at a capacity of 900 kg per hr were determined for certain waste compositions, heating values, excess air and heat losses. Specific heat and enthalpy are determined, as well as the amount of water needed to cool the flue gases to temperatures of 540, 400, 260, and 120 C. (Text in German)

68-0566

Fassler, K., H. Seib, and H. Spahn. Corrosion in refuse incineration plants. *Mitteilungen der Vereinigung der Grosskessel-Besitzer*, 48(2):126-139, Apr. 1968.

The condition of the waste heat boiler in the incinerator for the Badische Anilin- & Soda-Fabrik (BASF) after 42,000 operating hr is described. Despite a sometimes high hydrogen chloride content in the waste gases, no abnormal corrosion was seen in the waste gas tubes (maximum temperature in the tubes 350 C). Severe corrosion had occurred, however, on the rear walls of the tubes, between the furnace and the boiler where incrustation was prevented by the turbulence of the waste gas flow. To prevent this corrosion, flat iron straps were soldered to the rear wall of the tubes. This increased the life of the rear wall threefold. Using chemical analysis, and X-ray fluorescent and X-ray fine structure analysis, the tube incrustations at various points in the waste heat boiler were studied. The incrustations of the economizer were also analyzed with an electronic microprobe. The results of all these tests are given. They showed that since chlorides and

sulfates are present in sufficient amounts in all incrustations, some chloride and sulfate corrosion is unavoidable. From the extensive literature on corrosion a general pattern of chloride and sulfate corrosion can be seen. Above 400 C a cyclic process takes place which initiates temperature-dependent corrosion. There are three types of this: (1) corrosion in the gaseous state; (2) corrosion due to the formation of iron chloride and alkaline iron sulfate; and (3) corrosion due to the decomposition of iron chloride and alkaline iron sulfate. The latter two take place in the molten slag phase. No high temperature corrosion occurs in the incinerator of the BASF because the pipe temperatures are never above 400 C. A graph plots the dependence of corrosion rate on pipe temperature. (Text in German)

68-0567

Fink, F. and M. B. Ussar. Domestic refuse as fuel. *Verein Deutscher Ingenieure Zeitschrift*, 110(25):1,110, Sept. 1968.

The amount, the composition, and the characteristics of domestic refuse change with the season. During the winter months, the amount of refuse lies about 10 to 25 percent below normal. The volume of the refuse fluctuates by 15 percent around the mean annual value. Areas attractive to tourists show less fluctuation. As far as the composition of the waste is concerned, the sociological structure of the population is of importance. Districts in which coal-heated stoves and ovens are still in use have a high amount of ash in the refuse during the winter months. But the difference between the winter and summer refuse became less apparent over the last ten years. Domestic refuse shows a characteristic combustion behavior: it ignites rapidly but burns slowly. Domestic refuse is now burned in incinerators which have grates. Rotating vortex incineration, which proved to be suited to industrial wastes, is rarely employed, although it would be suited for this purpose as well. Any economic calculations must take into account the costs for the transport of the refuse to the incinerator. The larger the incinerator and the larger the area it serves, the more efficient its operation can be. With the present development of incineration technique, the optimum capacity of incinerators lies between 300 and 600 tons per day. (Text in German)

68-0568

Franzke, H. H. The designing of incinerators - illustrated by an example of a waste incineration-remote heating plant. *Elektrizitaetswirtschaft*, 67(18):521-527, Aug. 1968.

The planning and designing of incinerators is illustrated by the example of the City of Iserloh in West Germany. First, all possible methods of waste disposal were scanned for their usefulness. Dumping was not feasible because no dump sites were available in the area. The idea of composting had to be abandoned because there was no market for the compost. Therefore, it was decided that the wastes should be incinerated. It was found that it was economical to use the waste heat not only for the generation of electricity, but also for the remote supply of heat. The design of the incinerator was mainly determined by the fact that a waste accumulation of 70,000 tons per year was to be expected with the heating value lying between 800 to 2,000 kcal per kg. Three furnaces equipped with traveling grates, each with a capacity of 8 tons per hr, and an auxiliary oil burner, were decided on. Next the

size of the storage bunker was determined. A sure heat output of 10 Gcal per hr can be expected from these waste incinerators. Since the remote heat supply plant requires 60 Gcal per hr, it was decided that oil should be used for heating these boilers. During the summertime, the heat cannot be fully used by the remote heat supply plant and has to be conducted off into the atmosphere. Two air condensers serve for this purpose. In conclusion, details of the construction of the plant are discussed. (Text in German)

68-0569

Goeplert, J., and H. Reimer. The incinerator in Frankfurt am Main. *Energie*, 20(7/8):191-206, July-Aug. 1968.

Since the City of Frankfurt am Main no longer has enough waste disposal sites, it has had to turn to incineration. The plant with a capacity of 1,000 tons per day, which has already been designed and erected, is coupled to a remote heat supply plant. In the first full year of operation, a total of 242,000 tons of waste were incinerated by the two furnaces. Two other furnaces are just now (1967) beginning operation. Of the 288,000 tons of steam, 249,000 tons were delivered to the remote heat supply plant. The storage bunker of this new incinerator can hold 8,600 cu m of waste (dimensions 72 by 14 by 8.50 m). Sixteen trucks can empty their load simultaneously into the bunker. Two cranes bring the waste to the incinerators. Each has a grab capacity of 3 cu m. Of the four Von Roll furnaces, each has a maximum capacity of 15 tons per hr. Three furnaces can be operated simultaneously; the fourth furnace is used as a standby. The waste falls through a vertical, cooled chute onto the grate. A shaker loader automatically portions out the loads which charge the furnace. Primary air is drawn in from the storage bunker. Secondary air is blown in above the grate to avoid low oxygen zones. The flue gases are drawn in by an exhaust fan and cleaned in an electrostatic precipitator. Part of the cleaned gas is returned to the boiler; the fly ash is discharged into a water-filled basin. The slag is treated for further use in a scrap packaging plant which is also attached to the incinerator. The power supply of 6.0 kV comes from the neighboring remote heat supply plant. Old oil can also be incinerated by this plant at a rate of 10 tons per 24 hr. (Text in German)

68-0570

Gozo, L. Incineration of organic material containing mud in a fluidized bed oven. *Ingegneria Sanitaria*, 16(4):294-299, July-Aug. 1968.

The overall incineration process consists of four principal steps: removal of inorganic components; dehydration of the mud; incineration under fluidized conditions; and smoke treatment. Each step, however, admits of considerable variation. One of the contaminants, sand, is removed by centrifugation. In addition thickeners can be used to provide a more homogeneous mixture before it is dehydrated. Vacuum filtration with or without chemical additives (ferrous sulfate, lime) or a stainless steel separator can be used to dehydrate the material to about 30 percent solids. During incineration, naphtha and methane may be added, should this be required for satisfactory combustion. The mud is completely burned within 1 or 2 minutes. Fluidization decreases the amount of excess air from 20 to 40 percent and

that reduces mechanical maintenance of the equipment. The smoke treatment, disintegration, and cooling of ash and smoke, are performed under standard conditions. (Text in Italian)

68-0571

Heenan-Nichols continuous grate incinerator at Birmingham. *Public Cleansing*, 58(2):76-84, Feb. 1968.

A pilot plant utilizing the Heenan-Nichols continuous grate was built at Birmingham to determine the problems and difficulties associated with the design before contracting for a complete plant. The pilot plant operation from July, 1966 to November, 1967 is detailed, including problems encountered and how these were resolved. When the grates are preset according to the season and the nature of the domestic rubbish, the system works with extreme smoothness, giving satisfactory residue. The dust burden, measured at the chimney base, and measured in grains per cu ft at STP, and with the spray equipment operating, was 0.615 and 0.636. Two full-scale incinerators are to be built utilizing the information derived from the tests.

68-0572

Heiny, B. Incinerator for solid and liquid wastes. *Brennstoff-Waerme-Kraft*, 20(5):212-214, May 1968.

The incinerator plant of the Volkswagen factory in Wolfsburg, Germany, is described. Each day, the incinerator has to eliminate 140 cu m solid wastes, 2 cu m waste oil and oil sludge, and 4 cu m wax. It operated originally according to the flame chamber melting method developed by Wotschke (cf. *Brennstoff-Waerme-Kraft*, 16(8):383-391), but when too many problems arose, it was extensively modified and another method of incineration was chosen. A new incinerator was built. The modified plant consists of two parts: the incinerator with the waste storage bunker, and the heat utilization plant. The incinerator is loaded with the aid of a crane. Two rotating rollers transport the waste into the interior of the furnace. An oil burner is used to ignite the waste. The bottom of the combustion chamber rotates. The liquid slag flows into the post-combustion chamber. Here the incineration is completed. The waste oil and the sludges reach this chamber via two Ghelfi burners. The waste gases go to the boiler (capacity 12 Gcal per hr). With the heat gained here, about 15 percent of the entire heat requirements of the Volkswagen factory are covered. The incinerator has a capacity of about 3 tons per hr. The heat price of 17 DM per Gcal, which is necessary to cover all operating costs including amortization and insurance is comparable with the heat price of conventional heat plants. Several illustrations of the plant are given. (Text in German)

68-0573

Herrmann, L. Incineration of chemical refuse in cooled muffle and rotating drum furnaces. *Brennstoff-Waerme-Kraft*, 20(9):423-426, Sept. 1968.

The muffle furnace, which was first used for the incineration of chemical refuse, had no cooling system. High repair costs and long periods of inoperation, however, made the installation of a cooling system necessary. The entire furnace wall was removed, and the sheet steel casing was lined with a

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pipe system for natural water circulation. The space of 200 mm between pipes and casing was stuffed with glass wool. The pipes terminate on the top and at the bottom in a ring-shaped water collector. The pipe system is designed for a maximum capacity of 5 tons per hr saturated steam at 15 atm. The heating surface is about 90 sq m, the volume of the combustion chamber of the muffle is about 20 cu m. Liquid wastes are injected by burners of the simplest construction. An additional burner serves for heating up the muffle furnace. The ash can only be removed when the muffle is at a standstill. Because of the satisfactory experience with the waste cooled muffle furnace, a rotating drum furnace with a LaMont pipe system was constructed next for the incineration of residues from chemical plants. The plant has been designed for a capacity of 800 kg per hr of liquid refuse and 1,000 kg per hr of solid refuse. The steam which is produced amounts to 2.3 tons per hr at 22 atm. The plant has a concrete storage bunker with a volume of about 8.5 cu m. The flue gases are cooled to about 400 C and cleaned by cyclones. (Text in German)

68-0574

Hille, F. Incineration of residues from refuse composting in a rotating drum furnace. *Brennstoff-Waerme-Kraft*, 20(9):419-423, Sept. 1968.

The rotating drum furnace for incinerating residues from the composting of refuse in Landau, Pfalz, Germany is described. The furnace has actually two drums, one for drying, and one for the incineration process. Both drums have a separate drive. The drum for drying the composting residues is generally operated with a speed of about 2 rpm, the combustion drum with 0.2 rpm. The two drums can be either counter-rotated, or rotated in the same direction. A crane loads the composting residues into the drying drum. The residues from the incineration are cooled, and then discharged in the dry state. A wet cyclone is used for cleaning the flue gases, which are cooled to the point of condensation by injecting water. Occasionally, accumulating sludges are mixed with the composting residues and incinerated. Waste oil is injected into the combustion chamber via special burners. Four burners are installed in the furnace, one with a capacity of 50 to 100 kg per hr at the afterburning chamber. The plant in Landau has been in operation for 3,000 operating hr and so far has operated satisfactorily. The plant operates with a capacity of 15 to 20 tons per hr. Hardly any repair work had to be performed. The countercurrent principle which is employed, and which requires a drying drum of heat resistant steel, is, however only well suited for the incineration of refuse with a relatively low heating value and a high water content. It has been found that refuse with a lower heating value of about 2,200 kcal per kg can be incinerated. Illustrations of the plant and the equipment are given. (Text in German)

68-0575

Iitayama, N., K. Hishida, S. Konno, and T. Ohira. Research on refuse incinerators from the viewpoint of smoke properties. *Bulletin of the Japanese Society of Municipal Engineers*, 11(47):902-921, Oct. 1968.

The test results of comprehensive research carried out by the Department of Public Nuisance, Tokyo, concerning the

influence of the type and design of incinerators, operating conditions, and refuse properties on pollution due to smoke and ash, provide information for the improvement of the present policy of incinerator design and maintenance. Fifteen plants in the Tokyo area were selected for measurements, and the results of 10 typical incinerators are listed. The upper limit of the furnace outlet temperature, which is 950 C at present, was found to be slightly too high, considering the content of nitrogen oxides discharged from the furnace. It was difficult to decrease the content of organic acids, even through high temperature incineration. Satisfactory dust or fly ash collecting performance is illustrated for electric filters and the Doil scrubber. Problems for future study include: reexamination of test methods; relation of gas property and furnace type; special treatment of plastics; and improvement of batch combustion type incinerators.

68-0576

Hirsch, M. Corrosion of the heating surfaces on the flue gas side due to formation of iron chloride in waste incinerators. *Energie*, 20(2):32-35, Feb. 1968.

The chlorine liberated in the incineration of PVC (polyvinyl chloride) may be present in the flue gas either as elementary chlorine, or as hydrogen chloride. The fractions of chloride and hydrogen chloride depend on the partial pressures of the water and oxygen that is present. Since computations assume a moisture content of 30 percent by volume. The tests used in this report began with three types of wastes which contained 0.5, 5.0, and 25 g chlorine per kg waste. Furthermore, oxygen concentrations of 9.0, 1.0, 0.1, and 0.01 percent by volume in the flue gas were used. Results show that above 300 C, chlorine is present in the flue gas in form of hydrogen chloride. Chlorine forms volatile metal chlorides with various metals. In the waste incinerator, it may react with the iron in the heat exchanger material to form ferrous or ferric chloride. At the concentrations and temperatures prevailing in combustion chambers in which corrosions were observed, ferrous chloride is preponderantly present. A computation of the partial pressure of ferrous chloride shows that in an oxidizing atmosphere, no remarkable corrosion is to be expected. This situation changes when carbon or carbon monoxide is present. In waste incineration, an oxygen deficiency may develop due to the heterogeneous material even when the process takes place with a considerable air surplus. As a consequence, excessive amounts of carbon monoxide form in the flue gas, and ferrous chloride corrosion of the heating surface becomes feasible. (Text in German)

68-0577

The importance of small incinerators. *Brennstoff-Waerme-Kraft*, 20(9):428, Sept. 1968.

A report on the meeting of the Association of Municipal Motor Vehicle and Street Cleansing Departments which was held between June 25 and 30, 1968 in Saarbruecken, West Germany, is given. The highlight of the meeting was a paper presented by W. Kaupert, 'Selected Examples of New Composting and Incineration Plants.' The paper was mainly concerned with small incinerators, which perform an important task, but which are always neglected in discussions or descriptions of incinerators. Special mention was made of

(1) a muffle furnace for incinerating about 1.5 tons per hr (about 6 Gcal per hr) of waste oil, solvents and plastic material, (2) an improved version of the rotary cone furnace for 1 ton per hr of domestic and industrial refuse, (3) a Wiedermann rotating drum furnace which has a capacity of up to 5 tons per hr of refuse. For small incinerators, refuse delivered by trucks is emptied onto a platform from which it goes directly to the incinerator. Small incinerators are mostly privately owned and have so far been able to compete with municipal incinerators. The small incinerators, which are presently in operation, incinerate the refuse of only 5 percent of the population. Municipalities with a population of 50,000 or less possess no incinerator, and are forced to dump refuse. (Text in German)

65-0578

Incinerator for wet wastes. *Stadtehygiene*, 23(7):508, July 1968.

A new incinerator which burns wet vegetable and fish wastes without developing smoke or odors will be marketed this summer by the Japanese company Matsushita Electric Industrial Co., Tokyo. The incinerator is equipped with a 50 liter combustion chamber for normal wastes and with a 3 liter chamber for wet kitchen wastes. The incinerator is automatically ignited by two batteries. (Text in German)

68-0579

Incinerator plant. *Wasser, Luft und Betrieb*, 12(10):646, Oct. 1968.

An incinerator for moist and highly contaminated refuse was on display at the Hannover fair. It has a capacity of 250 liter per hr or 40 kg per hr referred to a bulk weight of about 150 kg per cu m. An additional oil or gas heater can be installed. The plant was equipped with an afterburning chamber where the flue gases are further heated up and burn out completely by adding fresh air. A multicyclone system cleans them before they escape into the open air. (Text in German)

68-0580

Incinerator prevents air pollution. *Materials Reclamation Weekly*, 112(25):16, June 22, 1968.

The Brule incinerator, of American origin, is claimed by the British manufacturers to burn anything wet or dry, without smoke, and to be within the limits of the Clean Air Act. The plant consumes anything that is combustible, and reduces it by 500 to 1. It can be installed inside or outside a building or placed as an independent unit. The patented three-chamber, semiparabolic arch design affords maximum reflection and heat concentration. The self-supported steel stack has a refractory lining for cool service and easy maintenance. The draught action that pulls the fire away from the loading door insures safety for the operator. There is no need for a water washing disposal works. Air is cleaned in the second combustion chamber. The rotating gases are scrubbed against the corners of the square chamber, the particulates falling on the floor. Gases then enter the up-pass virtually free of smoke, smell, or particles. The third chamber spins out the fly ash.

68-0581

Kaupert, W. Experiences with construction and operation of incinerators with heat utilization. *Stadtehygiene*, 19(8):153-159, Aug. 1968.

Incineration with heat utilization can be quite economical when the steam or the heat can be sold at reasonable prices, and when the incinerator is efficiently planned and constructed for this purpose. It is recommended that the boilers of an incinerator be connected with those of an existing remote heat supply plant to compensate for fluctuations in the heat output of the incinerator. The collection of waste must be performed with a view to heat utilization. Bulky wastes must be collected separately and crushed before they go to the incinerator. Crushing and homogenizing of domestic wastes must be discarded for reasons of economy. Scrap is not separated from the rest of the wastes because it loosens up the waste on the grate and permits better access of oxygen. Attention must be paid to the construction of the combustion chamber. The loading of the combustion chamber should not exceed 100,000 kcal per cu m per hr. The temperature should lie between 950 and 1000 C, so that the fly ash cannot melt and deposit on wall and pipes. The flue gas velocity should not exceed 4 to 5 m per second to avoid erosion. If a waste heat boiler is installed to cool down the flue gases to 250 or 300 C, it must be chosen so that it suits the combustion characteristics of the waste products. The economy of the incinerator is strongly influenced by the construction costs, the amount of heat, the price obtainable for heat, and slag. So far, heat utilization only covers the current operating costs. The specific costs per ton of waste are lower, the greater the caloric value. (Text in German)

68-0582

Kaupert, W. Production of gas from waste, experiences with the refuse gas plant in the Danish city of Kolding. *Brennstoff-Waerme-Kraft*, 20(9):433-435, Sept. 1968.

The Danish city of Kolding erected a gas plant which uses refuse instead of coal in the production of gas. The plant is illustrated, and its construction briefly described. The waste is shredded and stored until a monitor indicates that the level in the retort has become too low. The retorts are vertical chambers with a volume of about 4 cu m. Ring canals are provided for the heating gases which are cooled to 170 C in a heat exchanger. If oil is used for heating, about 0.18 tons per ton of waste are needed. This makes the operation independent of variations in the composition of the waste. Above the heat insulation zone, the mixture of gas and the condensation heat of the steam are used in a remote heat supply plant. Wastes which can be used for this purpose are domestic wastes, industrial refuse, plastic material, sewage sludge and waste oil. Through extensive experiments, data on the operation of the plant were obtained and are listed in a table. The heating value of the waste gas was on the average 3,290 kcal per cu m. The specific density of the gas relative to air is 0.59. It requires 0.18 kg of oil to produce 0.41 cu m of gas from 1 kg of waste with a heating value of 1,450 kcal. From this, 700 kcal are obtained for the remote heating plant. A cost estimate for such a plant is given, based on a city of 110,000 inhabitants. (Text in German)

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68-0583

Kaupert, W. A waste composting/incineration plant in Mittelwallis, Switzerland. *Staedtehygiene*, 19(6):120-121, June 1968.

A central waste composting and incineration plant, to provide for alternate burning or composting according to need, is being planned for Sitten-Mittelwallis, Switzerland. The composting/incineration plant will serve all the 51 municipalities (population: 80,000) in the Mittlewallis valley between Leuk and Fully. The larger industries and abattoirs, however, will have to provide their own waste disposal. The plant will treat 70 percent of the domestic wastes and only 30 percent of the industrial wastes. A total of 20,000 tons per year of wastes will be processed by 1970. Some wastes will be eliminated by incineration. The accumulated sewage sludge will be composted, and the compost not sold will be incinerated. The incinerator has a capacity of 3 tons per hr or 18,700 tons per year, i.e. 79 percent of the waste anticipated by 1990. The calorific value of the waste is believed to be between 900 and 2,500 kcal per kg. A combination composting and incinerating plant was found to be the best solution with the least cost for this area. Construction costs are estimated to be 5.6 million Sw Fr. Processing costs will be 28.80 Sw Fr per ton. Transportation costs will be 19.15 Sw Fr per ton. No heat utilization has been planned since it would not be economical for a plant of this size. (Text in German)

68-0584

Kempa, F. Processes of total elimination of sewage sludge. III. Wet combustion of sewage sludge. *Gaz. Woda i Technika Sanitarna*, 42(4):125-128, Apr. 1968.

The Zimmermann wet combustion process is described. This method finds growing application, especially in large sewage purification plants. An explanation is given both of the theory and industrial application of this method. In addition, variation of the wet combustion process, the Atomic Suspension Technique (AST), which is based on the oxidation of organic substances at high temperatures (760 C), but low pressures (0.14 atm) is also presented. The outlet gases from the reactor have a temperature of about 750 C, and they are utilized either as a source of energy or as a means to compact waste deposits. Although this process shows similar advantages to the Zimmermann method, it has not been utilized very often because of the following reasons: corrosion of the reactor interior, scaling, clogging of the spray nozzle, and uneven operation. Cost data are lacking for the AST method, but it is generally stated that these costs exceed those of the Zimmermann method. (Text in Polish)

68-0585

Kuilmann, A. Cities and municipalities cannot shun the necessity of incinerating waste. *Brennstoff-Waerme-Kraft*, 20(9):405-408, Sept. 1968.

In the 24 years between 1952 and 1976, the accumulation of domestic waste will most likely increase from 115 to 340 kg per inhabitant, a threefold increase. The heating value, too, has a tendency to rise. Curves illustrate these data. Apart from a few exceptions, waste is mostly dumped outside cities and municipalities. The number of dump sites is estimated to be about 30,000 in the Federal Republic of Germany. It is

often agreed that municipal incinerators cost too much, are too large, and can easily be replaced by dumping. However, the municipalities have not yet recognized the importance of sanitary disposal. Incineration of domestic refuse as well as of industrial waste poses considerable technical problems, but they are all solvable now. The problem of corrosion has to be dealt with, particularly when steam is produced in the plant. To compensate for fluctuations in the composition and amount of waste, it is suggested that heat be supplied to a nearby remote heat supply plant. To avoid incrustation of grates, the installation of a modern roller traveling grate, or of a rotating drum combustion chamber, is recommended. For small plants, the specific investment amounts to 240 to 250 DM per ton of waste per year. With large plants, the costs run to 90 to 100 DM per ton per year. This price does not include the costs for land and the flue gas cleaning equipment. The dumping of waste into sanitary landfills costs about 5 DM per ton without transportation costs. (Text in German)

68-0586

Law, D. K. Direct incineration-aesthetic design of plant. *Public Cleansing*, 58(12):647-655, Dec. 1968.

The various parts of an incinerator installation are considered from the viewpoint of lighting and cleanliness. It is observed that the layout of the necessary equipment may be varied considerably to give a building which is not only pleasing but which meets all the functional requirements of the process. In general, however, incinerators which are required to consume municipal refuse need special design considerations because of the variability of the wastes. In addition, high stacks and relatively compact facilities are usually required.

68-0587

Lenel, K. R. Incinerators in England. *Brennstoff-Waerme-Kraft*, 20(9):426-427, Sept. 1968.

Although incinerators were constructed in England before the turn of the century, this type of waste elimination was rare until recently. The reason for this was the lack of technical knowledge on the combustion of refuse. The first modern incinerator was built in 1966 in Derby, a city with a population of 130,000. The plant operates in two shifts and burns about 216 tons per day. Animal carcasses and bulky wastes are burnt in a separate combustion chamber which is connected to the main combustion chamber. The incinerator is equipped with two traveling grates. The ash is discharged via a belt which runs through water. International Combustion Ltd. which built the plant, guarantees that the residues will not contain more than 3 percent of combustible material. A second plant will begin operation at the beginning of 1969. It will burn a great part of the refuse accumulating in London. It is designed for a capacity of 1,333 tons per day. The waste will be delivered daily by up to 700 waste collecting trucks. The plant will have five drum boilers for 39 tons per hr of steam, at 44 atm and 455 C. One of the five boilers will serve as a stand-by boiler. The steam will be used to generate electricity. Depending on the heating value of the refuse, between 27 and 50 MW can be produced. The plant calls for grates with seven rollers which can be adjusted individually between 0.5 and 5 revolutions per hr. Illustrations of both plants are given. (Text in German)

68-0588

Luscher, K. H. The incinerator plant in Munich. *Elektrizitaetswirtschaft*, 67(18):538-542, Aug. 1968.

The electric company of Munich is erecting incinerators in the north and south of the city. They plan to use the waste heat for the generation of electricity and for the remote supply of heat. The incinerator plant is north of Munich and has storage bunkers with a total capacity of 9,000 cu m. The coal heated boilers are, in this case, separately set up. But the successful operation of this first stage of the plant led to the decision to no longer separate the furnace units at the second stage. The incinerator plant which is being erected in the south of Munich consists of the waste incinerator and of a main furnace which is operated with natural gas. The two units were separately erected because results in the northern plant were not yet known. The incinerator serves as a preheater for the main furnace. Repair work can be performed at each furnace without interrupting the operation of the other. After about 3,500 operating hours, the first corrosion problems were encountered in the plant in Munich north. There was a leak in the pipe system of the vaporizer of the incinerator. The corrosion attacks were found to be severest in the center of the pipes, but the corners were not attacked at all. About 100 m of pipes had to be replaced. The second stage of this incinerator plant with the combined waste/coal furnace showed no corrosion whatsoever after 10,000 operating hr. But here erosion was found in the area of the soot blowers. Also damaged by erosion were the air preheating pipes. (Text in German)

68-0589

Maikranz, F. Incineration of refuse and heat recovery. Experience with multi-fuel firings. *Mitteilungen der Vereinigung der Grosskessel-Besitzer*, 48(2):111-118, Apr. 1968.

The three different types of waste incinerator plants in Munich are compared. The incinerators all possess the same Martin grate type for waste incineration. The two boilers (Ia and Ib) of plant I located in the north of Munich can be heated either with coal alone, or with coal (60 percent) and waste (40 percent), or with waste alone at a lower steam pressure and temperature, without using the steam for the generation of electrical energy. The boilers have two separate combustion chambers, one for coal dust and one for waste. The waste is incinerated on a Martin grate at a rate of 25 tons per hr. The steam production of each boiler is 100 tons per hr at 540 C and 186 atm. After 3,500 operating hr (70,700 tons of waste), boiler Ia had the first leak in its piping due to corrosion. An investigation showed that the corrosive attack was severest in the middle of the walls of the combustion chamber and tapered off towards the end. The corners were not attacked at all. About 100 m of piping had to be replaced in each of the boilers. Both boilers showed erosions. The severest attack was observed in boiler Ib after 5,600 operating hr. The causes for the erosion are briefly discussed. Plant II has one common combustion chamber for coal dust and waste. It has a depth of 8.5 m, a width of 11.4 m and a height of 36.5 m. The plant has now been in operation for 7,290 hr without any evidence of corrosion or erosion. The installation of soot removers, however, caused some difficulties. Plants IV and V in the south of Munich are still under construction. They are patterned after plant I with two

separate combustion chambers, since the generation of energy is of primary importance. The waste heat boiler will serve as economizer for the main boiler. (Text in German)

68-0590

Manchester, H. Better ways to deal with waste. *Reader's Digest*, 92(551):39-40, 42, 46, Mar. 1968.

United States sanitation experts are learning from European communities about safe and inoffensive refuse disposal. Rosenheim, Germany, operates an incinerator which daily converts 75 tons of refuse into much-needed steam heat and electric power. Clamshell 'grabbers' load trash into the plant's concrete bins, and shaker or magnetic belts remove metal scrap after the burning process. The hybrid power plant in Munich burns both trash and coal, handling 45,000 tons of refuse a month. Like the Rosenheim incinerator, Munich's plant operating costs are covered by sales of steam and power, garbage collection fees, and sales of recovered scrap. Plants in Essen, Rotterdam, Milan, and Paris also burn trash and sewage to make electric power. At Kolding, Denmark, 18 tons of refuse per day are heated to make commercial gas for domestic use. Schweinfurt, Germany, employs the 'Brikollare process' to compress sewage and refuse into bricks of sterile, inoffensive compost. Wiesbaden has four 120-ft high, concrete towers with power-driven hammers that reduce waste volume by one-half. The first modern European-type incinerator in this country was at a Norfolk, Virginia, air base. Plans are being drawn for a similar but larger plant for Chicago. New techniques currently being explored with U.S. Public Health Service grants include refuse disposal pipelines and an 'incinerator ship.'

68-0591

The Martin Stoker. *Public Cleansing*, 58(2):56-64, Feb. 1968.

The Martin stoker was developed in Germany about 40 years ago, to burn low-grade fuels such as industrial wastes and slurries. This is accomplished on the Martin stoker by the adoption of the counterflow principle, that is, by causing materials to flow in opposite directions so that particles flowing down the grate come into contact with particles flowing up the grate. This is achieved by pushing hot refuse up the grate with the reciprocating uphill-pushing grate bars, and letting gravity move cold refuse down the grate. This reverse action not only levels out the heat output over the grate regardless of the type of fuel being fed, but as each grate bar is moving at the same speed, an actual levelling of the fuel bed results. The stoker and auxiliary equipment are illustrated.

68-0592

McLean, N. Gas cleaning plant and its application to refuse disposal. *Public Cleansing*, 58(3):106-113, Mar. 1968.

The regulations in Great Britain covering atmospheric pollution are discussed with regard to municipal incineration. The main factors influencing the generation of dust in continuous stoker incinerators are discussed. The design of the furnace, fire-bed draught, and on-load cleaning gear are all considered.

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68-0593

Meeting in Hamburg to discuss the incineration of waste. *Staedtehygiene*, 19(4):79-82, Apr. 1968.

The Vereinigung der Gross- selbesitzer (Association of Boiler Owners) held a meeting on February 2, 1968 in Hamburg to discuss problems of waste incineration. The present state of waste incineration was described by F. Nowak. Only 8 percent of waste is properly eliminated; 2 percent by incineration, and 6 percent either by dumping in sanitary landfills or composting. The remaining 92 percent is dumped. The waste which is incinerated varies in composition. Therefore, storage (not more than a week, however) before incineration is of advantage because it has an homogenizing effect. Crushing and mixing is also of advantage. Waste contains on the average 4 percent scrap; 1.5 percent of this is incinerated with the waste; 2.5 percent is sorted out and reused. The addition of sludge to the waste does not have a negative effect on incineration, and up to 40 percent by weight of sludge can be added. Also up to 50 percent of the refuse can be discarded tires. In a second report, by A. Riedlinger, it was stressed that the type of incinerator chosen depends on the composition of the waste. Industrial waste very often is quite different from domestic waste. The construction of an incinerator plant takes about 3 years. The incineration of waste oil is no problem but usually, despite this, 80 to 90 percent of all waste oil is still dumped. Glass splinters in waste have no ill effects on the sludge because they improve the sinter ability. In two other reports, the incineration plants of the City of Munich and of the Badische Anilin- & Soda-Fabrik were described. In a report on the hygiene aspect of waste incineration, it was stressed how hazardous the work in an incinerator plant is. The personnel is subjected to great heat, noise, and dust. The dust from the waste contains numerous bacteria. (Text in German)

68-0594

Meier zu Koecker, H., R. Huening, and K. Wissel. The flow behavior of combustible coal sludges mixed with oil. *Chemie Ingenieur Technik*, 40(9/10):478-482, May 1968.

Incineration experiments with mechanically dried coal sludges mixed with oil brought excellent results. The mixture of coal, water, and oil can be quite economically eliminated without leaving any residues. No special difficulties were encountered. A certain limit is imposed on the composition of the three-substance mixture due to its flow behavior. The results of viscosity and stability measurements are briefly reviewed and plotted in triangular coordinates where the curves of equal fluidity are also indicated. For a certain type of coal and grain-size distribution, the fluidity curves are determined by the characteristics of the fuel oil, its initial viscosity, and its polarity. The characteristics of the types of coal and fuel oils used in the experiment are listed in tables. A rotation viscosimeter was used to conduct the experiments. The dependence of the viscosity on the water and coal contents of the mixture was investigated with four different types of coal and two fuel oils. Graphs are used to illustrate the results. Generally it can be said that the viscosity increases with increasing coal content. With increasing water content, i.e. with decreasing oil content, the viscosity also increases. Experiments investigating the dependence of the viscosity of the mixture on the amount and type of fuel oil showed that the use of coal tar oils is limited because the

mixture swells too much. They can only be used when the amount of sludge in the mixture does not exceed 50 percent. The viscosities of mixtures with equal amounts of oil and water vs. the coal content are plotted. The curves show that the viscosity of anthracite sludge lies between those of gas-coal and fat-coal. It was also found that in all cases the viscosity is independent of time. (Text in German)

68-0595

Milan trims garbage costs with power generating unit. *Electrical World*, 170(14):32, Sept. 30, 1968.

By 1975 the City of Milan will be incinerating 2.5 million tons of refuse and creating 300 million kwh of energy. The city is currently burning 360 to 540 tons of rubbish per day in its first plant, providing about one-third of the city's electric power needs. Garbage, which is collected in disposable polyethylene sacks, is hauled to the plant by regular garbage trucks. Overhead cranes scoop 4 to 6 cu yd each from storage bins, and dump it into two furnaces (Vollund design) where the rubbish is burned at 1,000 C. No pretreatment or presorting is necessary and everything, including metals and glass, is reduced to an ash which has productive uses. Smoke is filtered through twin electrostatic filters to a tall chimney, so that less than 0.004 oz of material gasses escape into the atmosphere for every cu yd of refuse. According to estimates, the heat value of rubbish is 2,700 Btu per lb, and 0.6 lb of rubbish yields 1 kwh electricity. The new plant cost \$4.8 million, and operating costs run about \$1.50 per ton plus 7 percent amortization over 30 years.

68-0596

More scrap used in British designed furnace. *Materials Reclamation Weekly*, 113(9):22, Aug. 31, 1968.

Fifty percent more scrap can be used in the electric arc furnaces, made by GWB Furnaces, one of which has been installed at Clyde Alloy Steel Company. The furnace has cut the average melting time from 6 hr to 5 hr and can, if needed, use 100 percent scrap in a melt. With a capacity of 25 long tons, the furnace has a 12-ft 6-in.-diameter shell and a power rating of 7.5 MVA.

68-0597

New design furnace burns 10 tons per hour. *Surveyor and Municipal Engineer*, 132(3973):26-29, July 1968.

A new £390,000 refuse incineration plant of 10 tons per hr capacity, incorporating a high efficiency, fully automatic Heenan-Nichols continuous rocker grate which accepts unsorted refuse, is being built at Sutton-Coldfield, England. Incoming collection vehicles discharge refuse into a reception bunker with 600-cu-yd capacity. Crane and grabs convey the material directly to the refuse chute of the incinerator. The grate is of continuous rocking design and operates automatically. It takes the form of three inclined banks, each about 11 by 10 ft. Each bank has eight rows of transverse tilting sections separated by fixed intermediate bars. The drive is timed to tilt alternate sections in each bank forward, so that the burning debris is propelled progressively down the sloping grate in a series of steps. By this movement the refuse is agitated and broken up to insure maximum combustion.

Grate riddlings and clinker are to be discharged to a water-filled trough beneath the grate so that they are automatically quenched. Ferrous metals are extracted by an electromagnetic separator and delivered to a triple compression press. An electrostatic precipitator is claimed to give a grit collecting efficiency of 94 percent. All combustion is to be monitored and controlled at a central room to give a clear picture of the furnace interior at all times.

68-0598

A new direction for refuse incineration. *Verein Deutscher Ingenieure Nachrichten*, 22(36):20, Sept. 4, 1968.

A refuse incinerator with a rated capacity of from 25 to 250 kg per hr has been developed. It is composed of three parts, an incinerator, a heat exchanger and a dust collector. The heat can be used for heating workshops or rooms, or it can be used for preparation of warm water. The flue gases are cooled in a heat exchanger. Construction of this type of incinerator corresponds to VDI recommendation 2301, and it fulfills the Clean Air Act of the State of North Rhine, Westphalia. The incinerator is either equipped with an oil burner according to DIN standard 4787 or a gas burner according to DIN standard 4788. If the composition of the wastes permits, a mechanically operated, cone-shaped rotary grate can be installed. The primary air is blown in by a ventilator. At the height of the grate and in the afterburning chamber, secondary air is injected. Combustion is almost smoke free. A centrifugal separator is used for dust separation. The incinerator can be used for paper, cardboard, wood, textiles, leather, garbage, hospital waste, and soap pads. Small amounts of plastic material may be mixed with the refuse. The incinerator is space saving and simple to operate. (Text in German)

68-0599

Progress in building GLC's Edmonton incinerator. *Surveyor and Municipal Engineer*, 131(3946):35-36, Jan. 20, 1968.

Incinerator construction is underway on a site which was formerly occupied by sludge drying beds for a sewage treatment works. Eight London boroughs will deliver 18,000 tons of refuse to this plant, whose storage bunkers will have a total capacity of 22,875 cu yd. The heat from the incinerators will be used to produce steam which will eventually provide an output of 27 mw to be fed into the Electricity Board's system. Residual material will provide a source of income as the ash and clinker will be used for graded fill, and sent to steel mills as material for blast furnaces. The incinerator gases will flow into a row of five electrostatic precipitators which will control the stack emission to a limit of 0.05 grains per cu ft per minute.

68-0600

Refuse incinerator in Hamburg. *Verein Deutscher Ingenieure Nachrichten*, 22(24):5, 7, June 12, 1968.

Hamburg lacks disposal sites for its heterogeneous domestic and industrial waste, oily sludges, and harbor refuse. Thus, a new incinerator plant has had to be constructed with two types of combustion systems, namely grate and burner. Solid and half-liquid refuse is burned on the grate, and liquid refuse

is combusted by burners. The waste is shipped in special containers to the plant. A rotary crane is available for unloading the refuse-carrying vessels. The bulky waste is brought in by trucks, crushed and mixed with domestic and other solid waste material. It is then incinerated on a back stoking grate. The oil comes in special tank trucks, and is burned by steam from compressed air atomizers. The section of the plant for incineration of solid and semi-liquid waste has been designed for a capacity of 12 tons per hr with a gross heat production of 23 Gcal per hr. The waste-oil fired furnace is designed to produce 2.5 Gcal per hr. The two-belted, back stoking grate with 15 stokers and seven underfed air zones has an effective combustion surface of 31.2 sq m. At the end of the grate, auxiliary burners are installed. The solid waste is charged by a chute and a ram. The pasty refuse is mixed with the solid refuse (this initially caused considerable trouble). The oil burners are designed for a throughput of 150 kg per hr. The primary air is drawn in from the boiler house and generally requires no preheating. Only when the heating value of the refuse is very low is the combustion air preheated to 150 C. A Martin slagging facility is adjacent to the furnace. Despite the different types of waste, the entire plant has just one combustion chamber. The oil burners could be installed on the side walls. The entire plant is controlled from a command console and has the capacity of burning 100,000 tons of refuse annually. (Text in German)

68-0601

Reh, L. Incineration in the turbulent layer furnace. *Chemie Ingenieur Technik*, 40(11):509-515, June 1968.

Solid, liquid, and gaseous material can be incinerated in turbulent layer furnaces. A table indicates which types of material can be incinerated by this method, e.g. residues from roasting coffee, sewage sludges, sulfate waste, lyes, carbon and oil containing refinery sludges, etc. Successful incineration in the turbulent layer depends on the temperature, the gas velocity in the turbulent layer, and the caloric value of the material to be incinerated. The temperature which is permissible in the combustion chamber is also limited. At too high a temperature, most solid materials tend to cluster together or to sinter. Moreover, the grate and other components suffer. The upper limit is thus 1,200 C. The lower limit is determined by the combustion process, which slows at approximately 600 C. In addition, the gas velocity in the turbulent layer is limited by the kinematic viscosity of the gas, the density of the gas, the diameter of the particles, the density of the particles, and the grain size distribution of the particles. Examples for the incineration process with solid and liquid material are given, namely the roasting of sulfidic ores and iron chloride cracking. The incineration of liquid, solid, and gaseous substances together is demonstrated with refinery sludges. (Text in German)

68-0602

Reiferi, L. Projections of an incinerator of solid waste. *Ingegneria Sanitaria*, 16(2):207-215, Mar.-Apr. 1968.

The thermic value of various types of waste is calculated. The theoretical caloric value of a pure carbon compound is 8,100 kcal per kg, compared to an average value of waste of 4,700

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kcal per kg. On the basis of these figures, caloric values of complex waste can be mathematically determined if the composition of the refuse is known. The thermic value depends on water and ash content. A triangular diagram is plotted representing caloric values of refuse having varying quantities of ash and water. Air requirements for solid waste of varying composition are also calculated, and a diagram represents air necessary for satisfactory combustion. All these calculations are carried out using average combustion data for cellulosic compounds, which contain carbon, hydrogen, nitrogen, sulfur, and oxygen. The volume of gas required for different types of solid waste and the combustion yield are all treated mathematically, and diagrams are projected to determine the volume of smoke. Mathematical evaluations of combustibility of various types of refuse are given. Unless 25 percent of the solid waste material is combustible, auxiliary agents are required to increase combustion temperature. (Text in Italian)

65-0603

Report on a meeting in Mannheim on remote heating plants. *Elektrizitätswirtschaft*, 67(4):85-104, Feb. 1968.

A special committee of the German Association of Electrical Power Plants was host to regular meetings of engineers from the remote heat supply branch. Remote heating systems have experienced a great increase, so that a number of new engineers have had to be hired. To discuss their problems, they meet annually, visit various plants and hear numerous papers. A detailed report is given on all the papers and on the excursion program. All papers dealt with pure remote heating problems, and none were concerned with the supply of heat produced by the incineration of waste. However, an illustration of the power plant at Mannheim-Nord which is connected with a waste incineration plant is given. The power plant was visited by the participants, and their main interest was in the waste incineration plant. The two incinerators have a capacity of 18 tons per hr each at a heat development of 1,500 kcal per kg. The illustration gives a view of the entire plant with the oil containers, the cooling towers, waste water purification plant, the waste incinerator, and the waste storage building. Most of the plant belongs to the Energie und Wasserwerke Rhein Neckar AG (Energy and Water Power Company Rhein Neckar AG), and part of it to the Erdoel-Raffinerie Mannheim GmbH. (Text in German)

68-0604

Riedlinger, R. A. The incinerator in Dusseldorf—a joint undertaking. *Elektrizitätswirtschaft*, 67(18):535-538, Aug. 1968.

The incinerator in Dusseldorf has been planned and built in close cooperation with the industrial enterprises in the area, especially with the electric company. The construction work for the plant was begun in 1963. The first stage will have four furnaces (three for operation, one for standby), each with a capacity of 20 tons per hr. This first stage will be capable of incinerating 236,000 tons of waste per year. In its final stage, the plant will be equipped with six furnaces. The technical data for the first stage are listed in a table. The wastes, which are delivered by trucks, first go to a storage bunker. The furnaces are equipped with roller grates. The number of revolutions of each individual roller can be adjusted, as can

be the amount of air blown in. The ash falls from the last roller into a water bath, is cooled, and then goes to the ash treatment plant. The flue gases are cleaned with electrofilters. A total of 62 employees is needed to run the plant. Half of them are in charge of maintenance, which means that they are only part-time employees. The rest of the time they work with the electric company. Since evaporating water is the most effective means of cooling the flue gases so that they can be cleaned by the filters, steam becomes available. A 700-m pipeline brings the steam to the nearby electric power plant. Several agreements have been worked out with other industrial enterprises in the area in order to have constant consumers for the ash, slag, and scrap which accumulate in the plant (Text in German)

68-0605

Rotta, G. The incineration plant of Issy-Les-Moulineaux. *Ingegneria Sanitaria*, 16(5):365-369, Sept.-Oct. 1968.

This plant, which was in full operation in 1965, has reception and feed mechanisms designed in accordance with its site. Due to the proximity of the Seine and the presence of water-bearing strata, the deep ditches had to be avoided. The incinerating section of the waste disposal plant consists of four Martin furnaces. The boilers are based on the principle of natural circulation. Each furnace-boiler group is provided with auxiliary equipment necessary for startup and other tasks. To attain the most economic steam utilization, the following scheme was devised. All steam produced would pass through a group of turbo-alternators working at counterpressure. Once discharged, part of the steam would be used to heat the feed boiler water and another part would be diverted to heat urban housing. In 1965, in spite of its startup difficulties, the plant burned 362,000 tons of refuse. The thermic yield, guaranteed to be 8 percent, exceeded this figure. The total loss in calories for incombustible materials in the slag was approximately 2 percent. In 1966, 482,000 tons of waste were incinerated. Electrical energy was produced from 91 percent of the steam, which has an average of 76.3 kw-hr. per ton. Of this, 39 kw-hr. per ton were used internally in the plant, and 37.3 kw-hr. per ton were sold (Text in Italian)

68-0606

Rueb, F. Waste incinerators with heat utilization. *Wasser Luft und Betrieb*, 12(6):365-369, June 1968.

Various types of waste incinerators with heat utilization are described and illustrated. For extremely combustible waste such as paper, wood, cardboard, etc., which accumulates in hospitals and department stores and which can be burnt on the spot, small incinerators with heat utilization devices can be used. They have a capacity of 50 to 200 kg per hr with a heat output of 100,000 to 500,000 kcal per hr. An oil heater boiler with a water-cooled, oblique grate for wood chips, packing material, plastic material, and garbage has been developed. The boiler has a heat capacity of 3.25 Gcal per hr, and produces about 5.8 tons of steam at a pressure of 16 atm and a saturated steam temperature of 203 C. If the boiler is heated with waste material only, its capacity drops to 70 percent of the value given above. Industrial wastes in liquid form or which become liquid at the beginning of incineration are burned in a rotating tube furnace. Solid wastes can be

burned along with the liquid waste. The heat of the waste gases from the furnace is used for the production of steam. For the incineration of bulky wastes as well as fine-grained wastes with low calorific value and industrial wastes, an incinerator with a fully mechanical, counterthrust, cascade grate is used. Additional oil and gas burners are also used. The waste incinerator 'System Martin' has a mechanical, oblique grate which transports the lower layer of the glowing waste back to the entrance where the fresh waste falls on it, and is dried and ignited from below. The traveling grate incinerator is another type which can be used for the generation of steam. Large waste incinerators are mostly designed for heat utilization. The incinerator plants of the City of Bad Godersberg, of Berlin-Ruhleben (the world's largest incinerator plant with heat utilization) and of the Stadtwerke Hagen, are briefly described. (Text in German)

68-0607

Ruggeri, G. Incinerating plant for solid waste of the City of Geneva. *Ingegneria Sanitaria*, 16(6):445-452, Nov.-Dec. 1968.

The incinerator for solid waste in Geneva is one of the most modern and economical plants for waste disposal. It includes an administrative unit, a central unit which houses an automatic loading and unloading facility, and a main incinerating plant. The plant consists of two furnaces, each having a daily capacity of 200 tons. A relatively small ditch is used for waste received from the neighborhood. Domestic waste from the city is received by the river. The barges are directed toward a channel from which they are dragged out of the water for unloading by means of a winch. The key to the waste disposal system is this shuttle, river transportation. The fleet consists of one motorboat and four barges. A daily capacity of 480 tons can be attained, corresponding to a volume of 2,400 cu m. The cost of transporting waste from the collection centers to the plant amounts to 1 million Swiss francs per km per year. In comparison, cost for fluvial transportation amounts to approximately 250,000 Swiss francs without the necessary fleet and discharge equipment. A table indicates that from 1975 on, river transportation will be more economical than road transportation. (Text in Italian)

68-0608

Sheffield burns its sewage. *Engineering*, 206(5351):678-679, Nov. 8, 1968.

A multiple-hearth sewage incinerator, designed to burn 400 tons per day of pressed filter cake from an adjacent filter plant, is described. Burners are fitted to some of the hearths to initiate combustion, but from that point on the process is self-sustaining. Hot gases from the burning sludge at the bottom of the furnace move countercurrent to the feed of cold sludge filter cake, thus evaporating a large portion of the moisture in the feed. An empty chamber above the top burning hearth is used to raise the gas outlet temperature to prevent odors. An induced draught fan is provided for each furnace to draw a controllable amount of air through the furnace and scrubber. The hot gases from the furnace pass either through an emergency stack which is provided for each furnace, or normally, through water sprays for cooling to a cyclone scrubber which removes moisture and entrained dust.

68-0609

Short, W. Recovery of heat from refuse incineration. *Public Cleansing*, 58(9):491-502, Sept. 1968.

Every incinerator produces the equivalent heat of large tonnages of coal or oil. This heat is being thrown away while searches are increasing for fuels for heating purposes. The design of a heat recovery unit for an incinerator necessitates changes in the design of the furnace. Close attention must be paid to the operating temperatures and to the corrosive nature of the gases produced by the refuse. Design of such a unit is discussed. Diagrams indicating the probable boiler efficiencies to be obtained at different loads and calorific values, and estimated steam production from various loads of refuse are given. Refractory-wall incinerator plant versus waterwall generating incinerator plant figures are given. Use of the heat is sometimes difficult due to costs of distribution. The best possible use of the steam is through sale to an industrial plant, but this is often difficult to arrange. A further possibility is to utilize the steam in a power generator, which can be a favorable financial proposition.

68-0610

Smith, A. W. Electric overhead travelling cranes. *Public Cleansing*, 58(10):513-530, Oct. 1968.

With the introduction of rotary or continuous hearth grates for incinerators, the use of grabs or cranes for handling refuse is increasing. The polyp, or tukip, or hydraulically operated multiblade grab produces excellent compaction figures that can be maintained under a variety of conditions, and a much higher payload than with the equivalent-volume clamshell grabs. This greatly influences crane design. The selection of the various components on the crane is sometimes made by the user, and motors, control gear, brakes or brake solenoids can be obtained from several quality-conscious manufacturers. Care of the crane, considerations in the selection of equipment for various job requirements, accident prevention and safety maintenance, and reliability, are fully considered. Typical rope-operated grab clamshell calculations are tabulated.

68-0611

Stabenow, G. Performance and design data for large European refuse incinerators with heat recovery. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.278-286.

Design and performance criteria for the layout of large municipal incinerators are widely discussed, but a formal code for design and performance criteria is still in its preliminary stages. The trend in Europe involves feeding raw refuse into combustion chambers with a guaranteed high rate of burnout. The furnace walls are water-cooled to obtain a longer furnace life. The available heat is recovered and utilized for power or heat generation. The residue occupies only about 6 percent of the original volume of refuse fed to the furnace. A variety of designs from a wide range of municipal incinerators which have operated successfully in Europe over long periods are discussed. The heat recovered through generation of steam permits a thorough evaluation of

incinerator performance tests. As a result, it should now be possible to prepare performance specifications, and guarantees for high grade incinerator equipment. Rigid enforcement of such specifications will permit municipalities to select incinerators that will assure a long life and satisfactory operation. Data on refuse composition, flue gas analyses, and grate performance are given.

68-0612

Tanner, R. Experiences with the incinerator of the city of Lausanne. *Brennstoff-Waerme-Kraft*, 20(9):430-42, Sept. 1968.

The incinerator of the City of Lausanne, Switzerland, was built in the years 1956 to 1958 and began operation in October of 1958. It has two furnaces, each with a capacity of 100 tons per day, which are combined with a boiler delivering 10 tons of steam per hr (20 atm, 250 C). The furnaces and boiler are built according to the Von Roll system. Each furnace has two grates arranged on top of each other. The slag is cooled in a water basin. The flue gases are cleaned with the aid of electrofilters. The greater part of the heat goes to a nearby remote heating plant, and the rest is used by the plant itself. Since the incinerator plant is the only heat supplier for the remote heating plant during the summer, the operation of the incinerator may not be interrupted. So far, the plant fulfilled this requirement entirely. In 1967 it was possible to keep the two furnaces operating during more than 90 percent of the theoretically possible 8,760 operating hours. Since 1959, the amount of refuse incinerated increased by 103 percent, the population by 59 percent, and the steam production by 100 percent. In 1967, 240 kg per of waste per inhabitant accumulated. In 1959, the plant operated with 17 employees. This number increased to 26 in 1962 and 31 in 1967. In 1964, both furnaces were out of operation for a period of 840 hours since certain parts had to be replaced. (Text in German)

68-0613

Traynor, A. T. Direct incineration. *Public Cleansing*, 58(11):591-605, Nov. 1968.

The direct incineration plant consists of a refuse reception pit, and a crane which transfers rubbish to a continuously operating grate which emits a steady flow of ash, from which ferrous metals can be extracted. The design of the reception area, grab crane for furnace feeding, incinerator feed chute, the furnace including the construction, the grate designs, control of burning operation, ash composition and treatment, procedure for extraction of metals, flue gases and gas cleaning devices, and the chimney are all considered. Each of these items is examined in the light of current practice and problems involved in the operation of such an incinerator.

68-0614

Walter, L. Steam distribution system of Paris and the incineration plant at Issy-les-Moulineaux. *Public Cleansing*, 58(1):25-32, Jan. 1968.

The district heat distribution for Paris met a total demand for 1964 of about 745 Gcal per hr. The incineration plant at Issy-les-Moulineaux provides waste incineration with waste

heat recovery. The plant is operated on a 24-hr shift and has a nominal capacity of 400,000 tons per year of garbage. The use of waste heat boilers produces steam at 928 psi and 770 F. Electric energy is generated by passing this steam through a turbine of approximately 290 psi back pressure, and drives a 9,000 kw generator all year. In winter, back pressure steam is used for district heating. The plant equipment and arrangement are detailed and illustrated. Some data for incineration and boiler units are given, as are the characteristics of the waste heat boiler. Operational experience is given, and smooth and efficient operation is found. Use of electrostatic precipitators makes atmospheric pollution practically nonexistent.

68-0615

Wolf, R. Old tires don't fade away. *Rubber Age*, 100(2):68-73, Feb. 1968.

About 1 million tons of tires are removed from vehicles every year and the majority are not retreaded. Tire production is increasing every year while reclamation usage remains steady. The wide availability of relatively cheap synthetic rubber has lowered the demand for reclaimed rubber. From investigations carried out so far, the Rubber and Plastics Research Association (England) considers that controlled burning is the only satisfactory method of disposing of large quantities of rubber waste. A method of burning used tires which permits satisfactory burning rate, smokeless incineration, and adequate steam for an associated plant has been devised in England for the Watts Tire Company. The unit disposes of approximately 840 lb per hr of scrap, which raises about 3,500 lb of steam. Operating 24 hr per day, the incinerator will consume over 2,300 long tons of scrap per year. It was suggested that 133 small incinerator installations similar to the Watts installation would be necessary to burn all of England's waste rubber, at an investment of slightly over \$7 million. Criticism of such a plan was made by R. W. Tennant, president of the International Federation of Waste Rubber and Plastics Merchants, claiming that tires are a valuable resource. The Palma method of using old tires for the production of felt and textile-free rubber crumb is suggested.

68-0616

Wood-waste burning plant. *Materials Reclamation Weekly*, 113(7):25, Aug. 17, 1968.

Automatic wood-waste burning equipment has been installed for a furniture manufacturer in England in order to reduce fuel, transportation, and labor costs. The plant is built around an existing boiler installation which has a capacity of 3 million Btu per hr. It is claimed that the new installation will provide more heat for space heating. Waste heat radiators will be mounted externally to dissipate unwanted heat during the summer.

68-0617

Wotschke, J. Results from new considerations of the combustion process in incinerators. *Brennstoff-Waerme-Kraft*, 20(9):435-442, Sept. 1968.

A paper presented by R. H. Essenhigh at the National Incinerator Conference in May of 1968 in New York is

reviewed. Up to now only empirical data, such as those given by the Building Advisory Board, has been available for the volume of combustion chambers of incinerators. Refuse is listed in a table according to its respective characteristics. Empirical data concerning the grate and combustion surfaces are also tabulated for each group of refuse. An attempt was made to find a clear relationship between the empirical data for the volume and the combustion surface. He offered the equation: $F_{\text{sub A}} \text{ equals } K_{\text{sub I}} \lg F$, where $F_{\text{sub A}}$ indicates the combustion surface, F the amount of refuse incinerated, and $K_{\text{sub I}}$ is a constant. It was found that the larger the ratio between surface and volume, the more intensive the reaction, and the less equipment required. Next, the influence of the moisture content of the waste on the combustion was investigated. The moisture content is a parameter which reduces the flame temperature, which in turn has a dampening effect on the reaction process. The amount incinerated within a certain period of time is, thus, also reduced. The best way to avoid this is to increase the flame temperature. This is best achieved by vigorously mixing the flame gases directly above the combustion zone. The combustion air must be preheated to a high temperature. Auxiliary fuel guarantees a high flame temperature, even with increasing moisture content. (Text in German)

68-0618

Wulf, H. Elimination of toxic waste water through incineration. *Gas und Wasserfach, Wasser, Abwasser*, 109(12):326-328, Mar. 1968.

Industrial waste water is usually chemically decontaminated and neutralized, and the sludge left is dehydrated. Several kinds of apparatus and containers are required. Construction and operating costs are high. In contrast, the incineration of waste water is quite economical and efficient. Only half of the operating costs are required, and no preliminary preparation is needed. An oil gas burner is used as the incinerator. It consists of a heat-resistant cast iron casing attached to a combustion chamber. Oil and superheated steam are injected into the combustion chamber and are thinly dispersed. By blowing in air, part of the atomized oil begins to burn. This heats the remaining oil to a temperature at which it vaporizes completely. As a result, the temperature in the combustion chamber becomes extremely high. Waste water or sludge is pumped through a pipe into this preheated chamber. If the waste material itself has some calorific value, the burner can be adjusted. No odor or smoke occurs during incineration. In May 1967, 10 such burners began operation in a chemical plant to eliminate, hourly, 8 tons of mostly toxic, liquid waste material. The burners are arranged tangentially around the circular combustion chamber. The heat rising through the incinerator is used to produce steam. With a very simple modification at the injection pipe, the oil gas burner can be adjusted so that incineration of sludge becomes possible. The rod within the pipe is simply substituted for a tube with a diameter of 4 to 11 mm. The sludge is pressed through this tube into the flame of the burner. Sludges with a high water content as well as a high solids content can be burned equally efficiently. Two figures illustrate the oil gas burner. The operating costs of this large incinerator plant, including amortization within 3 years and interests, amount to approximately 50 DM per cu m without heat utilization and approximately 30 DM per cu m with heat utilization. Even if a suitable profit is added for the operator

of the plant, the costs of 120 to 140 DM per cu m waste water or sludge are still far below those of a chemical treatment plant where the operating cost is 310 DM per cu m. (Text in German)

68-0619

Ziemer, G. and W. Drewes. Operation and experience with the incinerator in Karnap. *Elektrizitaetswirtschaft*, 67(18):547-552, Aug. 1968.

The incinerator in Karnap serves the cities of Essen, Gelsenkirchen, Muehlheim, and Gladbeck (West Germany), which have a total population of 1.3 million. The incinerator has an annual capacity of 420,000 tons, and is equipped with 10 furnaces. The waste is brought on rubber conveyor belts to the charging zone, from which it is mechanically or, by its own weight, forwarded into the combustion chamber. The combustion takes place mainly at the center grate. The grate underneath serves for the last stage of combustion and for sintering the slag. Coal dust burners are used to ignite the furnaces. Illustrations of the plant and the grate are given. Waste heat is used to generate power. No traces of corrosion have so far been discovered. During 2 to 3 years of operation, incrustation has remained within acceptable limits. The waste collecting trucks are weighed at the entrance to the plant, before they discharge their loads into a storage bunker. The crane cabins are stationary and have an entrance from outside. Tables list the amount of wastes delivered within the period between 1965 and mid-1968. Many experiments have showed that industrial wastes may not be stored with domestic wastes, since the difference in the heating value is too great. Thus, another storage bunker was built for domestic waste. Waste oil is also incinerated at Karnap. Bulky wastes are first shredded at a rate of 150 cu m per hr. Iron parts are removed from the waste. The slag is sold and sometimes dumped. About 40 percent to 50 percent of the ash has been sold. (Text in German)

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68-0620

Albertson, O. E., and R. J. Sherwood. Centrifuge for dewatering sludge. *Water and Wastes Engineering*, 5(4):56-58, Apr. 1968.

The use of solid bowl centrifuges for dewatering raw and digested sludge has increased, due to the increased efficiency of the new designs. Also, major improvements in organic polyelectrolyte conditioning agents have greatly expanded their use. Improvements include rotational speeds as high as 4,000 g's for a machine that would formerly give only 600 to 1,500 g's. Of equal importance is the shallower bowl angle which permits more solids to be recovered. The operator can control the dewatering and clarification capacity of the machine by controlling the depth of the pool. Several tests, which are detailed, show that the recovery decreases as the feed rate increases. Correspondingly, the concentration of solids is affected by recovery. There is little need to use polyelectrolytes for dewatering digested primary sludges if the machine is loaded within its clarification capacity. Work conducted on digested primary and Biofilter sludge shows that the long-bowl unit would dewater three to four times the equivalent short bowl unit at the equivalent feed rate and

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efficiency. Costs are compared to other means of mechanical dewatering. Without chemicals, the solid-bowl centrifuge will classify digested sludge according to specific gravity and particle size. The result is a concentrate high in grease and organics.

68-0621

Aluminum swarf-drying plant cuts costs and improves yield. *Materials Reclamation Weekly*, 113(11):30-31, Sept. 14, 1968.

An unconventional yet money-saving aluminium swarf drying installation is the 'Intal.' Based on a dryer-cooler principle, it consists of a three-stage horizontal drum fitted with special internal flights. The dryer-cooler and afterburner operate by natural draught from the chimney stack, which delivers smoke and fume-free gases. Magnetic separation equipment can be fitted to remove tramp iron and steel from the swarf which is being treated. Heat from the oil content of the swarf is used for heating the swarf in the first stage. Tests showed that the dried swarf gives a metal yield between 98 and 99 percent. An all-running cost of £4.10s per ton of swarf is given for a 4-ft, 6-in. diameter by 24-ft-long dryer-cooler.

68-0622

Aronsson, G. Sludge dewatering with separators. *Process Biochemistry*, 3(9):49-51, Sept. 1968.

The town of Visby on the Swedish island of Gotland is using an Alfa-Laval sludge dewatering plant, employing centrifugal separators, to treat the effluent from a population of 30,000, of which 5,000 is equivalent to industrial waste. Sewage enters the plant and passes through a self-cleaning strainer and two aeration tanks in series, then to six sedimentation tanks, whose overflow is discharged into the sea. Sludge scrapers collect the sludge which is then thickened mechanically and fed to the dewatering tank. The dewatered sludge is collected in portable containers. Effluent is further treated in a self-cleaning clarifier, after removal of low density floating sludge. The self-cleaning clarifier is a centrifuge with discharge openings permitting sludge removal while the centrifuge is in operation. The containers with sludge are transported to an asphalt covered area with drainage outlets for compost. The liquid phase from the decanter is fed back to the sedimentation basins. The two-step process of clarification is described. The clarifier removes the greater part of the small particles. It is also possible to use synthetic polyelectrolytes to flocculate and remove the sludge from the decanter. The amount and type of polyelectrolyte depends on the type of sewage and the amount of clarification required. The design specifications for the plant are given and indicate an overall efficiency of 91 percent total.

68-0623

Bader, A. J. Complete waste treatment system designed for new foundry. *Plant Engineering*, 22(8):118-120, Apr. 1968.

A complete waste treatment system was designed for an iron castings plant in Illinois. During the planning stages, information on the quality and quantity of waste anticipated was gathered and water conservation methods were considered. Wet-type dust collectors are used which are supplied with spent foundry cooling water, and the sluice

water is pumped to a dust lagoon for settlement. The lagoon is able to provide 10-year storage volume and flood protection. Solid wastes will amount to 503 tons per day, and, of this, 500 tons will be waste sand from the core and mold-making operation. This will be used as fill for future buildings and to construct future settling ponds. Other solid wastes are removed by a local landfill operation. Spent water is emptied into the Illinois River at a maximum temperature of 105 F. Because of the variety of wastes, a batch treatment is used. Gravity sedimentation, pH adjustment, and air flotation are the basic treatments for this waste. Each waste-producing system was studied and isolated where necessary, and treatment was provided to equal or exceed existing State requirements. Continuing checks of the waste treatment system are made.

68-0624

Baillo, C. R., and W. D. Boyle. Activated-sludge nitrification in the presence of linear and branched-chain alkyl benzene sulfonates. *Applied Microbiology*, 16(1):62-68, Jan. 1968.

Biodegradable linear and branched chain alkyl benzene sulfonates, used in nearly all household detergent formulation, were investigated for their effect on activated sludge nitrification. A synthetic waste containing up to 23 mg of each detergent per liter was administered to eight bench-scale, batch, activated sludge units. The most obvious differences between the oxidized-nitrogen levels of the units fed the two types of anionic detergent and the controls were: (1) almost all (98%) of the oxidized nitrogen in the effluent of the detergent-fed units was in the form of nitrate, whereas only about half of the oxidized nitrogen of the controls was nitrate; and (2) the percentage of the oxidized nitrogen as nitrate varied directly (but not linearly) with the concentration of the LAS detergent applied to the units. Various hypotheses are offered to explain the phenomenon.

68-0625

Bakradze, L. L. Efficacy of the biothermal treatment of sewage at Georgian Centers for tuberculosis. *Hygiene and Sanitation*, 33(7-9):271-274, July-Sept. 1968.

Experiments were made with simple composting and with an improved dump. Test samples were placed in previously inserted perforated wooden conduits at depths of 20.50 and 100 cm and their temperatures were measured. A test sample, saturated with emulsion containing half a million type H sub 37 RW human tuberculosis bacilli, was left in the compost until humification occurred, which was mainly established by temperature observations. Field experiments showed that owing to climatic and other local conditions, a relatively high temperature was achieved throughout all the months of observation. Studies of the survival of tuberculosis bacilli under such conditions showed that with the temperature and environmental conditions prevailing at Abastumani, the bacilli were killed by both simple composting and an improved dump during the period of May to December, but retained their viability and virulence in the period from December to May. This method may also be used at any season of the year at the tuberculosis resort of Gulripshi, situated on the Black Sea coast near Sukumi, owing to climatic conditions which are suitable for the decontamination of solid wastes. Supporting data are charted.

68-0626

Balke, S. The importance of water in modern industrial society. *Staedtehygiene*, 19(5):86-90, May 1968.

In connection with a statement on the importance of a sufficient water supply to industry and on the necessity of keeping water unpolluted, a paragraph is included on the influence of dumped waste on water. According to the German Association for the Protection of Water, there are now about 30,000 waste disposal sites. Only a few have been tested for their possible harmful effects on ground water. Where it has been done, it almost always has turned out that the waste was not properly dumped, and that the ground water was polluted by harmful substances penetrating from the top. Moreover, in the densely populated Federal Republic of Germany, suitable disposal sites are becoming scarce. However, the dumping of waste cannot be completely abandoned because about 25,000 municipalities will not be able to eliminate their wastes in composting or incinerator plants, simply because of a lack of financial means to erect such plants. They will have to deposit their wastes in sanitary landfills. Another acute disposal problem arises from the enormous amounts of sludge which accumulate in waste water purification. An industrial state must solve these problems, and the state must also make it possible to deposit industrial wastes at special sites which will be designed so that no pollution of ground water occurs. Because of the many unsolved problems in waste disposal, there is a desire to make the ocean a dumping ground for wastes. This would have dangerous consequences if no international regulations are worked out, which would on the one hand relieve industries of their waste disposal problem and on the other hand protect the oceans from harmful pollution. (Text in German)

68-0627

Bark digs up a market. *Chemical Week*, 102(16):92, Apr. 20, 1968.

A New York-based forest products company last year sold 56.7 million lb of sylvichemicals, two of them made from the bark of the firm's staple pulp tree, the western hemlock. The bark is normally burned as fuel after being stripped from logs at the mill. The company, however, uses hot water to extract polyflavonoid compounds. These compounds form chelating agents for trace minerals which are exploited in a line of fertilizers. They also form water-impermeable gels that make effective grouting agents. This line of gels has great potential if it can be used to firm up tunnels, foundations, atomic test holes, and deep mines. Unlike cement, the gel can be pumped through fine sand; its latest application is the stabilization of Florida sand in which power and light poles are anchored.

68-0628

Beerbower, R. C. Maintenance of refuse disposal areas. *Coal Age*, 73(2):102-106, Feb. 1968.

Efforts to stabilize soil and beautify the area at the U.S. Steel, Maple Creek mine, New Eagle, Pennsylvania, are described. Since the coal portal and preparation plant are within a populated area, refuse disposal presented a problem. The decision was made to transport coarse fractions underground by rail, and to transport washer-refuse slurry by pipeline to the company's Ginger Hill Shaft, approximately

3.3 miles away. There, an automatic hoist is used to lift the coarse fraction 532 ft to the surface for distribution over a disposal area. The slurry is channelled to a settling pond on the same site through a discharge borehole cased with 5-in. extra-strength pipe for gravity separation. Prior to wasting the refuse, the disposal area was cleared of all combustible material, vegetation, and topsoil to eliminate ignition. Coarse refuse is hoisted to the surface and spread from scraper-loaders over the wasting area in layers approximately 8 to 10 in. thick, and tightly compacted by scraper-loader traffic. Slopes of the refuse area are maintained at ratios of 1 to 1 or 1 to 2. A spoil-bank reclamation program was initiated, and the slopes were covered with clay to a thickness of about 10 in. and planted with stabilizing vegetation (pine seedlings).

68-0629

Benson, R. J. Centrifugal sludge dewatering. *Water and Wastes Engineering*, 5(9):56-57, Sept. 1968.

A centrifuge was installed to dewater 10,000 gal of domestic sludge weekly in a city of 14,000 on the northern edge of San Francisco. Centrifuging eliminated the need for sludge drying beds, and freed that area for other municipal land needs. The plant facilities include: a bar screen, shredder, detritus tank for grit removal, pre-aeration, postchlorination, a centrifuge for dewatering digested sludge, five raw sewage pumps with a rated capacity of 500 rpm to 4,500 rpm, and a sewage gas operated standby pump with a rated capacity of 4,500 gpm. Plant data and a flow diagram are included.

68-0630

Biaggi, N. The sugar industry in Puerto Rico and its relation to the industrial waste problem. *Journal of the Water Pollution Control Federation*, 40(8):1423-1433, Aug. 1968.

During the 1966-1967 milling season, 22 sugar factories were operating in Puerto Rico, where the production of the cane sugar industry has shown a steady decline in the last 5 years. The wastes from the cane milling process are: bagasse or the woody fiber of the cane; the filter cake; cooling and condenser waters; and concentrated wastes from spillage, scum leaks, and washings. All of the bagasse is utilized either as fuel for the factories or in the manufacture of paper. The most convenient way to dispose of the filter cake is by spreading it on a field as fertilizer or soil conditioner. The high BOD concentration of cooling and condenser waters indicate that too much sugar is being lost into them by entrainment. The concentrated wastes such as molasses and sugar spills are small in volume, but have a high BOD concentration. Since the sugar factories do not have sufficient cane to mill or to process economically, it seems advisable for the government to provide incentives conducive to industrial efficiency in controlling and reducing wastes.

68-0631

Bishop, S. L., and G. P. Fulton. Lagooning and freezing for disposal of water plant sludge. *Public Works*, 99(6):94-96, June 1968.

The methods available for treatment of waste sludges from water treatment plants are: alum recovery, filtration, disposal

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to the sewerage system for treatment, lagooning, and freezing. Alum recovery is usually not considered economical because of equipment and maintenance costs. Discharge to the sewerage system simply transfers the problem to the sewage treatment facility. If sewage sludge is dewatered on a vacuum filter for ultimate incineration, the filter backwash water requires reduction of the peak rate of discharge at the sewage treatment plant. A properly designed lagoon can serve both as a settling and thickening facility. The lagoon in use at the Shermont Water Treatment Plant of the Monroe County Water Authority near Rochester, New York, is described. The aluminum hydroxide, holding the enmeshed particles removed from the water during the treatment produces a sludge which contains water of hydration. It is this water that can be released by freezing in northern climates. To demonstrate the effect of freezing alum sludge, samples were obtained from the Monroe County Water Authority treatment plant and frozen. Freezing increased the total solids concentration of the sludge from 3.5 to 17.5 percent and caused a significant decrease in volume. When the sludge thawed, the hydroxide did not revert to its original gelatinous state. Design parameters for the disposal of waste sludge by lagoon freezing are listed.

68-0632

Blackbirds sewage works. Consulting Engineer, 32(6):44, June 1968.

One of the purest effluents in Great Britain will be produced at the Blackbirds sewage works in West Hertfordshire. Suspended solids and BOD of 7 ppm will be produced at the works. Effluent from the final activated sludge separating tanks will be further treated with sand filters. At Blackbird and the Maple Lodge works, sludge is treated and disposed of by three separate processes. Part of the sludge, from the activated sludge process, is dewatered by vacuum filters, and is dried in furnaces to produce a fertilizer which is sold under the tradename "Covonic." Most of the sludge is treated by a fermentation process (digestion), and is then distributed in liquid form as a fertilizer to the land. Some of the dried sludge from drying beds is lifted by mechanical means, and is used as a fertilizer or fill.

68-0633

Boettcher, F. The 1968 meeting of waste water experts in Berlin. Gas und Wasserfach, Wasser, Abwasser, 109(36):984-988, Sept. 1968.

Between April 4 and 5, 1968, 600 waste water experts gathered in Berlin to discuss pressing problems in this field. The paper "Methods of waste disposal with a view to keeping our natural water resources unpolluted," was presented by H. W. Leonhardt from the central agency for waste disposal at the Federal Department of Health in Berlin. The paper stated that the inconsiderate dumping of wastes is no longer acceptable and must be abandoned completely. Sanitary landfill is to take its place. By crushing the wastes, and dumping them in layers which are covered with earth and then compacted, many health hazards are eliminated. To avoid any spoilage of the groundwater, dump sites must be made impermeable. The assumption that sterile ash can be just dumped without any precautionary measures is erroneous because it can contain water-soluble salts which pollute the groundwater. Compost is also to be used with

caution, since plants absorb the salts as nutrients. None of the methods now used to dispose of wastes is without danger to the ground water. (Text in German)

68-0634

Born, R., and U. Moller. Natural hydroxide sludge dehydration in drying beds. Wasser Luft und Betrieb, 12(5):300-303, May 1968.

While experience has been gained with the natural dehydration of organic sludges, little is known about the natural dehydration of inorganic sludges. However, a number of plants for the artificial dehydration of hydroxide sludges exist. These plants have shown that the water-binding ability of hydroxide sludges varies greatly. The initial concentration, the type of heavy metal hydroxide, the neutralizing agent, and the mechanical strain of the flakes formed at neutralization all affect the dehydration ability of the sludge. During the natural dehydration of hydroxide sludges, they form cracks much more rapidly than organic sludges, which seems to indicate that hydroxide sludges dry faster. Experiments carried out in almost square drying beds with a surface of about 4.5 sq m should give information on the drying process of various hydroxide sludges, and they should show how much influence weather conditions have, and under what circumstances the best results can be expected. The drying beds were filled twice. Each layer was about 40 cm thick and had a solids content of about 8 kg per sq m. The experiment lasted 29 days, and the sun's radiation varied markedly during this period. The precipitations were limited to a few days. The experiments showed no remarkable influence of the precipitations on the drying process. A comparison with roof-covered drying beds made this clear. Iron hydroxide sludge dried best. The capillary water was separated during the first 10 days. An experiment, which lasted 54 days, tested the influence of the thickness of sludge in the drying beds and the solids content on the dehydration process. The solids content is decisive for the final water content, as a graph shows. With this experiment, too, the capillary water disappeared within the first 10 days. The results indicate that the sludge thickness in a drying bed should correspond to a solids content of about 8 kg per sq m. If a 10-day rhythm of starting and completing the drying process is maintained, a theoretical drying bed capacity of 288 kg dry substance per sq m per year can be expected. The results of the experiments have been confirmed by practical experience. (Text in German)

68-0635

Boubel, P. W. Particulate emissions from sawmill waste burners. Oregon State University Bulletin No. 42, Corvallis, Aug. 1968. [21 p.]

In the manufacture of lumber or plywood, considerable waste material is produced. One method of disposal of wood residues is incineration in a Wigwam-type burner. Particulate emission data from the incineration of wood residues in Wigwam burners was investigated. One hundred individual samples were taken from nineteen burners located in the Pacific Northwest. Gravimetric and size analyses were made on each of the samples. Results indicate the extreme variability of these burners. Particulate emissions ranged from a low of 0.004 grains per cu ft to a high of 0.607 grains per

cu ft. Particulate emission from an average burner was estimated at 0.168 grains of particulate per cu ft of gas (corrected to 12 percent CO₂ and STP). This is equivalent to approximately 10.7 lb of particulate per ton of fuel consumed. The particulate has two distinct size distributions, one representing the smoke (less than 2 microns) and one representing the material which would settle from the atmosphere downwind from the burner (larger than 10 microns). This information enables control officials to evaluate these burners for particulate emission quantities, size distribution, and transport characteristics of the emissions.

68-0636

Boubel, R. W. Procedure. In Particulate emissions from sawmill waste burners. Oregon State University Bulletin No. 42, Corvallis, Aug. 1968. p.2-6.

One hundred samples at nineteen waste burners in the Pacific Northwest were taken using a probe operating from the ground. The sampling train, used in all tests, was designed to collect all of the particulate in a form suitable for both gravimetric and size analysis. The analytical procedure was to clean and dry the sampling elements before each test. After the test was completed and the components returned to the laboratory, the particulate was washed from each collecting element, except the membrane filter, with distilled water. A drop of the liquid was then placed on a microscope slide and the particle size distribution was determined. The remaining liquid was evaporated in a dried, tared evaporating dish. The weight of the sample was then determined. Sample weights on the order of 5 mg were collected with the sample train. The samples were then ashed by placing them in a muffle furnace at 750°C for 30 min. After cooling, they were again weighed to determine the percent ash. Data tabulation and reduction were done after all samples were analyzed. Variables of interest were: (1) weight gain by the membrane filter; (2) weight gain by the train ahead of the membrane filter; (3) percent ash in the particulate; (4) average temperature of the gas during the sampling period; (5) particulate emission per unit volume of exhaust gas; (6) draft ratio, which indicated the amount of leakage through the burner shell; (7) size analysis of particulates on the membrane filter; and (8) size analysis of particulates in the sampling train ahead of the membrane filter.

68-0637

Boubel, R. W. Results. In Particulate emissions from sawmill waste burners. Oregon State University Bulletin No. 42, Corvallis, Aug. 1968. p.6-10.

Results indicated that each burner is significantly different from the average, and that they must be considered as individual sources. The average draft ratio for all 100 tests was 0.49 which indicates that about one-half the theoretical draft can be expected from a Wigwam burner. The particulates emitted from the typical waste burner were about 37 percent ash. This indicates that it would be about one-third consumed (100 percent would be complete combustion; the wood has about 1 percent ash originally). The emission temperature was 485°F, which is considerably below the 600 to 900°F temperature recommended for smoke-free operation. The loading to the atmosphere was

0.168 grains per cu ft of gas corrected to 12 percent CO₂ and standard temperature (60°F) and pressure (30.00 in. of mercury). This value is considerably below the value used by many control agencies of 0.3 grains per cu ft. The particle size distributions showed a significant difference for that material collected in the train ahead of the filter, and for that material on the filter itself. Two distinct size distributions were noted upon microscopic examination of the collected material. One was a larger particulate capable of settling to the ground as dustfall. Another distribution was noted for the smaller particles which are seen as smoke, and are referred to as suspended particulates.

68-0638

British sewage plant for City of Geneva. Water and Waste Treatment Journal, 11(11):498-499, Jan.-Feb. 1968.

The public works authorities in Geneva have completed the construction of an entirely new sewerage system with sludge dewatering plants concentrated at Aire, Nant D'Avenir and Villette. At Aire, the sludge is digested before reaching a Porteous Plant. It was anticipated that the bulk would be reduced by some 20 percent, and at the same time, methane gas would be produced. This gas is used primarily to supply heat for the digester. After treatment, the press cake is discharged directly into barges for transportation, along with the city's refuse, to an incinerator plant situated downstream on the river Rhone. The Porteous Plant is designed to treat the sludge from a population of up to 400,000. The installation is automatic, requiring only two laborers for filter press duties and a supervisor.

68-0639

Brooks, R. B. Heat treatment for activated sludge. Water Pollution Control, 67(5):592-601, 1968.

Experimental work is reported using 1 percent solids surplus activated sludge to determine the effect of initial solids concentration, temperature, heating time, and presence of oxygen on many of the system's parameters; to examine various physical and biological methods for treating the liquor produced; and to evaluate the residual non-biologically degradable compounds which exert a chemical oxygen demand. Full details of apparatus, techniques, and results are given. Temperatures in excess of 130°C must be used with activated sludge of 1 percent concentration; otherwise the separation of the liquor will be difficult by filtration or centrifuging. Equilibrium by simple solution of dissolved solids and soluble organic nitrogenous material was quickly approached. Longer process times resulted mainly in more chemical reactions taking place. Heat treatment at 130°C destroyed the water-holding ability of the sludge within 1/2 hr. Aerated heat treatment did not easily or markedly reduce the COD. Total soluble phosphate and colloidal matter were reduced marginally by aerated heat treatment. The production of ammonia and volatile acids was enhanced by high temperatures, long process times, and the presence of oxygen during heating; the proportions indicate that after a small initial release of volatile acids, the ratio of ammonia to volatile acids was constant. These conclusions were based on 1 percent activated sludge heated to between 100 and 216°C for 1/2 hr to 24 hr.

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68-0640

Brown P., and A. Thomas. Some experiences in the consolidation of surplus activated sludge. Surveyor and Municipal Engineer, 131(3952):33-36, 60, Mar. 1968.

Introduction of a new activated sludge plant had the main effect of increasing the proportion of activated sludge solids in the mixed sludge from 17 to 46 percent on a dry weight basis. In addition it reduced the amount of supernatant material that could be removed during consolidation of the digested sludge from 36.4 percent to 7.8 percent of the original volume. Thinner sludges were obtained from the sedimentation tanks, and the undigested tanks yielded less supernatant liquor. Settling on a laboratory scale thickened activated sludges after 4 to 5 days to 3.1 percent solids. Laboratory scale digestion with a 30-day retention period allowed a further 30 percent reduction in volume, yielding a sludge of 2.8 percent solids. Pressure flotation, using a pilot-scale unit, yielded sludge of 3 to 5 percent solids with a comparatively clean supernatant. Centrifuging in an 11-gal-per-minute unit yielded sludges with 9.3 to 9.8 percent solids. The sludge was in the form of a paste, and the centrate contained highly disintegrated solids. Heat treatment at 180 F gave consolidated sludges of 7.7 to 12.2 percent solids, the supernatants having BOD's of between 1,500 and 10,000 mg per liter depending on the thickness of the feeds. Double consolidation on a plant scale of up to 20 ft of hydraulic head, produced sludges of between 5.0 and 8.8 percent solids with BOD's of up to 7,000 mg per liter for the supernatant. Polyelectrolytes at up to 0.6 percent of dry weight can hasten settlement.

68-0641

Buelow, R. W., B. H. Pringle, and J. L. Verber. Preliminary investigation of waste disposal in the New York Bight. Narragansett, R.I., Northeast Marine Health Sciences Laboratory, Jan. 1968. 33 p.

According to the U.S. Army Corps of Engineers, there are 17 loading points for sewage sludge to be hauled to sea in the New York City-New Jersey Metropolitan Area. The total volume for the year 1964-1965 was 3,965,876 cu yd. The digested or partially digested sludge is hauled by barge or tanker to a disposal area designated by the Corps of Engineers. The purpose of the study was to acquire data on bacterial distribution resulting from the discharged sewage sludge and to provide assistance in planning future studies on dispersion and the effects of waste discharges at sea. The bacteriological determinations are tabulated in the appendix. Results indicate that coliforms can survive for a time when concentrated on the bottom. The rapid reduction of coliforms indicated by the results can best be explained by a combination of dilution with the receiving sea water and death due to the disinfecting power of the sea water column. Little evidence indicates that stratification was of any consequence in the dump area during the study. Long-term, detailed analyses of sludge drift and bottom currents are needed in the entire region, as well as environmental information concerning the bottom organisms.

68-0642

Burd, R. S. A study of sludge handling and disposal. Water Pollution Control Research Series Publication No. WP-20-4. Washington, U.S. Federal Water Pollution Control Administration, 1968. 326 p.

The available literature on the various steps involved in sludge treatment and disposal is summarized. Different methods for each step are compared according to economic and geographic considerations, and conclusions are drawn as to future trends. The sludge treatment techniques covered are: clarification, thickening, blending, digestion, elutriation, dewatering, and heat drying. These disposal methods are also covered: lagooning, landfilling, ocean disposal, composting, combustion, and pyrolysis. Sludge piping is considered and compared with other means of transportation. The economics of different sludge handling and disposal techniques are compared, and the problems of odor control and sludge disinfection are outlined. Lastly, the treatment of water treatment sludges is covered. A list of 450 references is included at the end of the book, and many graphs, tables, and diagrams from these references, needed to illustrate the techniques covered in the chapters, are reproduced. Suggestions are made in the conclusion for areas of future work. The need is stressed for organization of this research on a national level.

68-0643

Carpenter, W. L., J. G. Vamvakias, and I. Gellman. Temperature relationships in aerobic treatment and disposal of pulp and paper wastes. Journal of the Water Pollution Control Federation, 40(5):733-740, May 1968.

Studies of aerated stabilization basins at temperatures of 2 to 30 C are summarized along with studies of activated sludge process performance at temperatures of 26 to 52 C. The aerated stabilization basin process occupies the area between low-rate, extended aeration activated sludge treatment and long-term storage, and natural stabilization basin treatment. Process efficiency can be varied by changes in retention time, supplemental aeration, nutrient control, and secondary sedimentation. In studying the temperature relationships in treatment and disposal of pulp- and paper mill wastes, BOD removal during aerated stabilization basin treatment was found to be adversely affected by temperature reduction below 20 C. A common value of 1.016 for the temperature coefficient ϕ , correlating with the deoxygenation rate constant $K_{sub 1}$, was found to be uniform for raw and treated mill effluents, and to equal 0.2 at 20 C. The temperature coefficient ϕ , relating 5-day and ultimate BOD with temperature, was found to equal 1.035 and 1.031, respectively, for mill effluents. The BOD-removal reaction rate, constant $k_{sub 1}$, ranged on the average from 0.20 to 0.50 at temperatures of 2 to 30 C, respectively. The optimum mesophilic temperature for activated sludge treatment was 37 C, with progressive deterioration in performance resulting as the operating temperature was raised to as high as 52 C.

68-0644

Carroll, R. G. Hydraulic systems for swarf removal. Plant Engineering, 12(8):653-658, Aug. 1968.

The removal of swarf from the cutting zone of the machine to the velocity trench is a major factor in the success of the complete operation. The most efficient velocity trench has a U-shaped section with a semicircular base. The main factors affecting velocity trench design are: material and nature of swarf, allowable trench depth at entry to the main settling tank, amount of flushing required and position of flushing jets, and the liquid depth and velocity. The size of the

settling tank should generally be sufficient to contain eight to ten times the volume of coolant passing through the system per minute. The settling tank is divided by a weir into a dirty and a clean section. The actual filter unit for the removal of fine particles of swarf depends upon the degree of filtration required, the type of metal removal operation, and the nature of the swarf, the coolant velocity and flow rate, and the temperature of the coolant entering the filter. The most efficient are the following: vacuum and pressure types which use either permanent or disposable filter media, and a pre-coat filter with diatomaceous earth for use when extremely fine filtration is required.

68-0645

Centralized disposal. Chemical & Engineering News, 46(52):18, Dec. 9, 1968.

A centralized disposal facility that handles the industrial wastes of nine chemical and refining plants has gone into operation in Canada, near Sarnia, Ontario. The system incorporates five different disposal methods and handles 37 types of liquid and bulk waste, including styrene, ethylene glycol, amines, miscellaneous solvents, carbon black, scrap polymers, and separator cleanings. A new bulk waste incinerator, and a burial area for inert residue and bulk materials was added to a traveling grate incinerator constructed to burn 2 tons per hr of trash and garbage. The new incinerator burns 20 to 25 tons per day of oil-soaked paper and rags, scrap plastics, greases, and oil-soaked clays. With the additions to the existing capability, the entire plant is designed to operate efficiently at an input volume of 30,000 to 75,000 cu yd of waste per year.

68-0646

Centralized waste disposal: an answer to air pollution. Safety Maintenance, 135(4):43, 44, 52, Apr. 1968.

Design of a nuisance-free, centralized industrial waste disposal facility involved extensive engineering and equipment studies. After developing the final design, related capital and operating costs computer studies were made to determine the cost directly attributable to specific waste materials and to provide an equitable basis for assigning fees. A \$5 million special, high temperature, high-efficiency, waterwall furnace installation utilizes available by-product energy and reduces disposal charges. Other equipment provides means for handling difficult industrial products. The 20-acre facility will process 10,000 tons per month of industrial wastes. During operation, wastes are selectively blended and fed to the proper oxidation unit—rotary kiln, multiple hearth, or rotating grate. Destructive decomposition takes place in two stages, supplemental natural gas firing of volatiles and complete combustion at temperatures in excess of 1,800 F. Over 100,000 lb per hr of by-product steam is recovered. An efficient multiple stage electrostatic precipitator is used, and the gases are exhausted through a 400-ft stack. The facility was designed by a Houston Corporation, COPE.

68-0647

Centrifugal dewatering of waste sludge. Water and Sewage Works, 115(1):47-48, Jan. 1968.

The waste from a major papermill in the South is chiefly from the pulping, bleaching, and papermaking operations. A

vacuum filter system was discontinued in favor of three 40-by-60-in. solid bowl centrifugals for dewatering sludge. Sludge, drawn from the underflow of three separate clarifiers, is treated by the centrifuge system, which has a combined capacity of 300 gpm. Dewatered sludge, in the form of cake averaging 29 percent solids, drops through hoppers onto a conveyor and is hauled by truck to a landfill. Effluent water from the centrifugals contains solids and is returned to the clarifiers for resettling.

68-0648

Ceresa, M., and L. E. Lancy. Metal finishing waste disposal. Metal Finishing, 66(4):56-62, Apr. 1968.

Metal finishing wastes which are harmful and toxic to the bacteria utilized in biological sewage treatment process are: cyanides; simple metal ions such as copper, chromium, cadmium, zinc, and iron; and concentrated processing solutions which may be alkaline or acidic. Legal considerations concerning water pollution and drinking water standards are discussed. Metal finishing wastes, their origins, and recommended treatment are described and listed in tabular form. Control of contamination includes: properly designed and racked parts; use of dragin and dragout stations; countercurrent flow, stagnant, and fog spray rinsing; regeneration of spent chemical processing solutions; substitution of processing solutions; mechanical descaling; and good housekeeping and proper segregation of processing tanks.

68-0649

Ceresa, M., and L. E. Lancy. Metal finishing waste disposal. Part 2. Metal Finishing, 66(5):60-65, May 1968.

In the treatment of toxic contaminants in effluents or spent processing solutions, chemicals may be added to precipitate or destroy the toxic compounds. If a precipitate is formed, it must be removed from the effluent before it is discharged. Batch waste treatment systems are suited mainly to small and medium sized plants for the treatment of cyanide or chromium containing effluents. Continuous treatment systems are more practical than batch treatment, for plants handling very large amounts of cyanide and chromium wastes. In the 'Integrated Waste Treatment System,' the waste treatment is integrated into the processing sequence, and no separate treatment plant is required. Ion exchange is a method of concentrating the chemical contaminants in rinse waters so they can be treated more easily, and it makes possible the recovery of valuable materials.

68-0650

Ceresa, M., and L. E. Lancy. Metal finishing waste disposal. Part 3. Metal Finishing, 66(6):112-118, June 1968.

The best opportunities for ion exchange systems in metal finishing waste treatment lie in the field of valuable metal recovery or regeneration of process solutions. Recent developments with 'moving bed ion exchange columns' are described. The electrodialysis process has potential for regeneration and purification of process solutions, because it uses a small area of active ion-exchange surface which regenerates itself continually and does not require chemical means to bring the ion-exchange resin back to its initial form.

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Closed and open loop systems are being used in handling cyanide and chromic acid plating waste operations by evaporation. Precipitated hydroxides, after being concentrated in the form of well-compacted sludge, must be handled by a clarifier. The sludge removed from the clarifier can then be discharged to a sludge thickener, a sludge bed, or a pressure or vacuum filtration system.

68-0651

Central vacuum cleaning system saves \$18,000 annually. Mill and Factory, 82(2):80-82, Feb. 1968.

By installing a central vacuum cleaning system in the Metallurgical Products Department and providing sufficient vacuum outlets, General Electric now uses one man to clean the entire floor area, as well as all interior and exterior surfaces of each piece of equipment. Annual savings total \$18,500, of which \$12,000 is a result of powder recovery based on reclamation of product contents, \$2,500 in fuel savings by reduction of exhaust air, and \$4,000 in labor savings. On the basis of these cost reductions, the system will amortize itself in about 2½ years. Another benefit of the system is the improvement in potential safety and health. The equipment and operation of the vacuum cleaning system are described.

68-0652

Chapman, D. D., R. W. Okey, and F. T. Santler. Polyelectrolyte coagulants for use in the liquid-solid separation of high-solids activated sludge. Report No. SAM-TR-68-39. Seattle, Scientia Research Laboratories, Inc., 1968. (Distributed by National Technical Information Services, Springfield, Va., as Publication No. AD 672 818.)

The use of the activated sludge process to treat wastes arising in a remote environment appears to be feasible, if the process can be successfully miniaturized. A major problem in the development of equipment has been the continuous separation of effluent of satisfactory quality. A method was needed for pretreating the mixed liquor to allow continuous or semicontinuous phase separation of the high-solids activated sludge. Experimentation indicated that a substantial degree of filterability could be achieved after pretreatment. A method of phase separation for a miniaturized activated sludge facility has been developed, employing plastic filters and polyelectrolyte coagulants. It was concluded that: high-solids activated sludge may be successfully concentrated by flocculation with Dow C-32 polyelectrolyte, and the clarified liquor removed by filtration through a variety of plastic media; a residual quantity of coagulated and flocculated algae grew on the effluent; polyelectrolyte coagulants improve the quality of filtrates derived either from raw waste or from mixed liquor; the effectiveness of the coagulant was found to be a function of the ratio of the mass of cells (as COD) to the mass of coagulant; the coagulant C-32 was found to persist in an activated sludge culture for 3 to 7 days.

68-0653

Chapman, W. H. Destruction of organic matter in sludge digestion. Surveyor and Municipal Engineer, 131(3966):39, June 8, 1968.

Crude sludge in a sewage works is digested to convert organic matter to gaseous and liquid products. In heated primary

digesters there is no appreciable reduction in the volume of the sludge, but the solids are reduced by the destruction of organic matter. In secondary digestion tanks, the sludge is allowed to settle, since consolidating the sludge is the primary purpose. Several formulae have been suggested for use in calculating the percentage destruction of organic matter in digestion. All these formulae require certain assumptions but can be useful guides if used correctly. The Meltzer equation is a general equation allowing for changes in volume. This is useful for cold digestion processes or if overall destruction of organic matter is required. For normal practice, the O'Shaughnessy and Van Kleeck formulae, as applied to primary digestion, are adequate, provided that, in the derivation, it is assumed that the sludge volume before and after digestion is constant.

68-0654

Clarke, D. G. Resin emulsion wastes no longer a sticky problem. Water and Wastes Engineering, 5(11):46-48, Nov. 1968.

A new technique, for use on waste water from the production and use of aqueous film-forming emulsions, yields a solid phase which can be filtered or settled out of the waste water. Addition of a finely divided solid such as clay, fly ash, or sewage trickling filter sludge, followed by a flocculant such as Primafloc C-7 or ferric chloride and lime, will coagulate the emulsions. Experiments using these additives were carried out, and typical results of pilot plant experiments and details of the plant operation are given. When trickling filter sludge is used the emulsion waste can be handled with the sludge and the disposal problem is halved.

68-0655

Clyne, R. W. Mechanical retrieval of waste oils and solids from water. Lubrication Engineering, 24(11):514-520, Nov. 1968.

New machines designed to control industrial pollutants at various levels, including free (surface) oils, floating oil/water emulsions, suspended solids, and solids such as oily water materials with settlement characteristics, are reviewed. Rotating cylinders have been used for the recovery of oil spills from inland waterways and for the retrieval of waste (free) oils from waste water. Recent developments in compact machinery are presented for the separation of settled solids from waste water, cutting coolants, metal washing solutions, and quenching media. Ejection of the retrieved solids from the water is accomplished in the vertical plane. In contrast to pumped sludges, the solids content of ejected railroad sludges is about 40 percent by weight. A primary, mechanical, nonchemical, oil-water-solids separator has the capability of reducing the oil content in waste water from about 85,000 ppm to an average of less than 100 ppm.

68-0656

Coackley, P. Sludge dewatering and disposal. Institution of Civil Engineers Proceedings, 41(1968-1969):623-626, Nov. 1968.

A general discussion of the problems and processes of sludge dewatering, the chemical nature of the sludge particle, and engineering aspects of a treatment plant which have bearing upon the sludge produced is given. Some aspects of the

problems of final disposal are covered, and land disposal is considered the best solution in the widest context. Various additional topics were examined, including long-term disposal of sludge, and its effect upon the land.

68-0657

Coal preparation...quality for all mistakes. *Coal Age*, 73(10):146-158, Oct. 1968.

Model mining companies emphasize efficient operation, maximum recovery of saleable products, and protection of the air and water. Dewatering of table refuse and dust collection techniques are described. Where the terrain permits, trucking is the accepted means of refuse disposal. Aerial tramways, belts with trucks, or pumping are sometimes employed. Impounding is practically universal for fine refuse to prevent discharge of solids to streams. Crushing refuse is an increasing practice to provide a more favorable size, and to facilitate compacting. Many strip operators truck refuse into a pit and cover it with overburden, which eventually is reclaimed and planted. Operations and equipment are described in detail and illustrated.

68-0658

Cohn, M. M. How to clean a sludge digester...without fanfare...and with a contractor. *Water and Sewage Works*, 115(8):350-352, Aug. 1968.

The primary digester of a sewage treatment plant was not equipped with grit chamber facilities, and cleaning was necessary in 4 years. The work was undertaken by plant operating personnel and plant sludge-drawing facilities, and took a total of 4 1/2 months. Ten years later, it was decided that both the original tank, and the tank which had handled the load during the cleaning of the first tank, should be cleaned. The previous experience led to the hiring of a contractor with adequate facilities and manpower to do a quick job. The price was \$3,820 for the second digester, which contained approximately 1,960 cu ft of vertical wall depth plus the contents of the bottom hopper. The work was completed 7 days later. The other tank was cleaned in 3 days, at a cost of \$2,500.

68-0659

Conner, W. R., and M. J. Perry. Treats liquid waste more efficiently. *Food Engineering*, 40(2):92-94, Feb. 1968.

The liquid waste treatment system in the kitchen of the Sara Lee plant in Deerfield, Illinois, is described. A desludging centrifuge was installed in the bakery's preliminary treatment system to reduce suspended solids and meet the village's limitation, set at 300 ppm of BOD or 350 ppm of suspended solids. The primary treatment facility handles approximately 200,000 gal per day of plant waste exclusive of sanitary and storm waste. Liquid wastes are retained 48 hr in the treatment plant. This covers the period from the time when the waste enters the facility, until it is discarded from final clarification into the municipal sewer system. The clarifier operates at a capacity of 350 to 400 gpm. It accepts sludge with an average of 1 to 1 1/2 percent solids content (dry weight basis) from extended aeration tanks, and concentrates it to 5.5 to 6.5 percent solids. Occasionally, the solids are concentrated to 8 percent. The result is that the heavier

concentrated sludge is now trucked to disposal. The effluent from the clarifier now contains only 60 ppm suspended solids, far under the required 300 ppm BOD.

68-0660

Consolidation of surplus activated sludge. *Water and Waste Treatment Journal*, 12(12):530, Mar.-Apr. 1968.

The biological oxidation of settled sewage by the activated sludge process or percolating filters normally gives rise to large amounts of relatively thin, secondary sludges which are usually returned to the inlet of the primary sedimentation tanks. During co-precipitation with the primary solids from the sewage, the consolidation of the biological sludge is enhanced, and the resulting mixed sludge (which contains from 30% to over 60% secondary sludge on a dry basis) is much thicker than the weighted average of the primary and secondary sludges when consolidated separately. A survey of the methods used for reducing sludge volumes includes the use of polyelectrolyte flocculants, centrifuging, and pressure flotation.

68-0661

Contract disposal catches on. *Chemical Engineering*, 76(25):138, 140, Nov. 17, 1968.

The concept of centralized facilities for industrial wastes is becoming more popular in the United States. These units not only take the problem of safe disposal away from client firms, but frequently cut disposal costs as well. A little over a year ago, no such plants were operating on the continent, and even now only one unit is running. But by the end of January 1970, two more facilities should be working. At least 20 other plants are in various stages of design. Four companies head current contract-wastes-disposal activity—about \$40 million in potential plant investment is involved. A number of factors favor centralized-disposal units. First, although a large plant may be able to reasonably justify the capital expenditures for onsite treatment of wastes to acceptable pollution standards, medium and small-size plants may find the economic rationale for the outlay less sound, if not lacking. As pollution limits become progressively stricter, the larger-scale, a centralized unit, is better able to adjust due to operating economics. Acidic wastes from one plant and alkaline residues from another can be mixed to effect neutralization, or at least cut down on the amount of pH-control chemicals required prior to further treatment. Also, when material is slated for incineration, high-heat value wastes from one source can be added to low-heat value wastes that otherwise would be hard and/or uneconomical to burn. Rollins-Purle has pledged \$32 million to construct a grid of 20 plants across the United States at the rate of about four a year. Treatment methods, various Canadian complexes, as well as other companies involved in the venture are listed.

68-0662

Coping with industrial wastes. *Industrial Water Engineering*, 5(1):35, Jan. 1968.

A centralized industrial waste disposal facility was announced by Consolidated Oxidation Process Enterprises (COPE) of Houston, Texas. The 20-acre facility will process 10,000 tons of industrial wastes per month, delivered by barge, rail, or

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truck. Various wastes are selectively blended in the plant and fed to the proper oxidation unit. The first stage employs supplemental natural gas firing to insure destruction of volatiles, and in the second stage, complete combustion is facilitated by operating temperatures in excess of 1,800 F. Over 100,000 lb per hr of by-product steam is recovered. A multiple-stage electrostatic precipitator is used to reduce particulate matter.

68-0663

Corner, J. T. Waste tip stabilization in the Ruhr. Colliery Guadian, 216(5576):250-253, Mar. 1, 1968.

Waste tips from mining areas require stabilization to prevent washouts so that internal leaching and pollution of groundwater with sulfates and chlorine may be avoided. A system used in Germany for selecting a site, constructing a tip and planting the resulting mound is described. A base area of about 315,000 sq m and a planned final height of 90 m is envisaged, and at the present rate, the 31 million ton capacity will be reached in 20 to 25 years. The material, handled entirely by contractors, is dumped in five terraced levels, and tip dimensions are guaranteed to give a natural external slope angle of 35 degrees. Planting is systematically carried out by up to four men as soon as ground surface becomes available. At the base, trees are spaced at 10 m intervals. Strict controls are imposed in regard to heating within the tip and the pollution of water caused by the absorption of sulfate.

68-0664

Cottle, B. J., H. Neubauer, J. Buck, and R. M. Billings. Treatment of combined kraft and newsprint effluents at an Alabama paper mill. *Journal of the Water Pollution Control Federation*, 40(7):1,314-1,331, July 1968.

Waste water from the pulp and papermaking process at the Coosa mill must be treated for two reasons: to remove escaping fibrous material that might settle out in the river, and to reduce the organic material. The construction of dams upstream from the mill necessitated a change in the former waste treatment system. The new effluent treatment plant was situated across the river from the mill, making it possible to retain the original settling basins to be used during periods of clarifier maintenance or other emergencies. The facilities are described in detail, including a breakdown of construction and operating costs. The supernatant effluent from the clarifier now flows to a 370-acre, 1.4-billion-gal lagoon. The amount of accumulated solids in a year of operation is extremely high and engineering studies are being made with a view to installing presses after the centrifuges, to increase the dryness of the solids. Settleable solids have been eliminated essentially from the mill effluent going to the river and the BOD has been reduced by 30.0 to 79.7 percent overall, depending on the season and retention time. The problem of optimizing the BOD reduction in the lagoon still remains.

68-0665

Coughlan, J. P. Treatment of pulp and paper wastes. *Water and Wastes Engineering*, 5(9):8-10, Sept. 1968.

The utilization of less expensive construction materials and simplified designs is important in the construction of

facilities for treating pulp and paper wastes. Cost for structures represents 40 to 70 percent of the cost of a primary or secondary waste treatment plant. In the past, savings in treatment were achieved by providing differing levels of treatment for the different plant wastes, but new Federal and State regulations are jeopardizing this economical procedure by emphasizing uniform treatment of all discharges. Mechanical aerators, instead of bubble air, are seen as better choices. Mechanical dewatering devices are better than lagooning, due to the large amounts of land required for lagooning and the need for continuous sludge removal. Although sludge dewatering reduces the volume of sludge substantially, a large amount of material is still produced, and incineration, separately, or with bark, is expected to be practiced extensively. Treatment of pulp and paper wastes in a municipal treatment plant offers possibilities of Federal and State construction grants. Disadvantages include a difference in costs between municipal and industrial treatment plants, and guarantees are often asked that the operating costs be met, even if the industry discontinues operation. The most promising trend in treatment of pulp and paper wastes is reduction in quantities, sometimes through proper sizing of process equipment.

68-0666

Culp, G. Secondary plant effluent polishing. *Water and Sewage Works*, 115(4):145, 147, Apr. 1968.

Mixed-media filtration of activated sludge effluent, without chemical coagulation, provides effective removal of suspended solids and related BOD. At a total cost (capital and operating) of about one cent per 1,000 gal, suspended solids and BOD of less than 5 mg per liter, and turbidity of less than 5 Jtu can be achieved when filtering the effluent from a properly operated activated sludge plant. The mixed-media concept incorporating coal, fine sand, and very fine garnet, approximates ideal filter gradations and provides an effluent filtration system. Although a mixed-media filter can tolerate higher suspended-solids loadings than can the other processes discussed, it still has an upper limit of applied suspended-solids at which economically long runs can be obtained. With suspended-solids loadings of up to 120 mg per liter, filter runs of 15 to 25 hr at 5 gpm per sq ft have been maintained. A reliable system of tertiary filtration will require an effluent of uniformly good quality, or some intermediate treatment, to reduce excessive solids concentrations prior to filtration.

68-0667

Culp, R. L. The world's most advanced wastewater-purification plant. *American City*, 83(8):77-78, Aug. 1968.

The discussed project is the culmination of an 8-year program of the South Tahoe Public Utility District to preserve the beauty of crystal-clear Lake Tahoe by removing the threat of eutrophication, which might otherwise be caused by the drainage of algal-feeding nutrients from the resort and recreational developments around the lake's south shore. The laws of both California and Nevada require the export of all waste water from the Tahoe basin by 1970. The reservoir, created by the new rock-filled dam, will be receiving water that is clear, colorless, odorless, and practically free from

trouble-causing phosphates and nitrogen. The complete system is described. Disposal of the biological sludge from the primary and secondary treatment units is accomplished by burning in a multiple-stage incinerator. It is first thickened to about 25 percent solids by an air flotation thickener and a solid bowl centrifuge. Most of the phosphates removed by the treatment process are contained in the lime sludge. By the end of this year, the entire south shore of Lake Tahoe will be served by a sewer system, and all effluent will be exported from the basin as reclaimed water.

68-0668

Cummins, R. L., and T. J. Sorg. Industrial solid waste management studies. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint F-2.)

The Solid Wastes Program is engaged in developing information on collection, storage, disposal problems, and the quantity and characteristics of industrial solid wastes. Studies have been initiated on solid waste management in the demolition, junked automobile, and tobacco industries. Contracts dealing with polymer, rubber, printing and publishing, chemical, electrical appliance, automotive, and drug industry wastes are being considered. Information and data on industrial solid wastes will enable the assessment of pollution regulations and allow government officials to make responsible judgements in dealing with these wastes.

68-0669

Dahlstrom, D. Sludge dewatering. Chemical Engineering, 75(22):103-107, Oct. 1968.

Thickening rates of sludge depend not only on the nature of the waste, but also on its feed concentration, the specific gravities of the solid and liquid fractions, and the desired underflow concentration and overflow clarity. Thickening prior to centrifuging may give a substantial advantage. A recent development in thickening is the use of a reaction-type clarifier before dewatering. There are three types of centrifuges: conical, which gives good dewatering and classification but has poor clarifying capacity; cylindrical, which delivers a high-grade clarified liquid, but has poor dewatering ability; and combined, which gives good dewatering, classification, and clarification. Vacuum filtration is also used for dewatering with the bulk of the solids being retained on the surface of a drum while the liquid is drawn through the filter and discharged. Various mechanical means are used to remove the filter cake from the drum. The problem of blinding or clogging of the filter has led to continuous belt filters, which are continuously cleaned by high pressure water sprays. Cakes, as thin as one-sixteenth of an in. or less, can be discharged. The filter feed can contain as much as 100 percent of minus 200 mesh solids. The gravity filter consists of two cells which are operated at atmospheric pressure so that the solids are constantly being deposited on the filter medium and then the solids are drawn to another chamber where they are rolled continuously into a cake. A precoat medium is sometimes used on the filter of a vacuum type consisting of 2 to 6 in. of diatomaceous earth or perlite to aid the filter medium in separating fine colloidal particles which will not settle.

68-0670

Dalton, F. E., J. E. Stein, and B. T. Lynam. Land reclamation—a complete solution of the sludge and solids disposal problem. Journal of the Water Pollution Control Federation, 40(5):789-804, May 1968.

Three principal drainage areas and sewerage systems serve Chicago. The present methods do the job reasonably well, but are still not the final solution, because dump sites for the processed sludge and sites for holding lagoons are disappearing rapidly. This situation is further aggravated by high costs, air pollution problems, nutrient wastage, and the buildup of fines, nitrogen, and phosphorus in the waste water treatment process. Digested sludge, wet air oxidation sludge, Imhoff sludge, and heat dried sludge processes are practices that are presently being employed. Digested sludge processes provide stabilization only, and do not significantly change the sludge's nitrogen and phosphorus content. Wet air oxidation stabilizes, but fails to reduce the nitrogen and phosphorus. The Imhoff digestion apparatus only provides stabilization. Manufacturing low grade fertilizer from drying activated sludge is but a massive filtering and drying process. This costly process causes air pollution. A land reclamation method apparently solves the problem. The solution is compatible with urban, environmental standards, and economically solves the problem into perpetuity while conserving organic material. Digested sludge would be applied to the farmlands through irrigation systems tilled into the soil and then farmed on a rotating basis. Data shows where this process has been previously employed. Digested sludge contains the three basic elements necessary for vigorous plant growth. It also increases humus content, soil fertility and structure, vitamins, water holding capacity, and moisture supply control. University of Illinois demonstration plots will investigate relevant aspects of the process. Also included in the article is a partial list of areas utilizing sewage wastes.

68-0671

Darcy, C. B. 2800 HP sludge vessel is newest in NYC fleet. Diesel and Gas Turbine Progress, 34(6):58-59, June 1968.

The City of New York recently placed in service a 324-ft sludge vessel to dispose of anaerobically digested sludge from a sewage treatment plant at sea. The vessel is a twin-screw, semi-automated ship. The sludge system is completely operated from a central control console located on the main deck in the forward section of the deck house. The sludge will be discharged, by gravity, through 20-in. dump valves located in the bottom of the vessel. Sludge pumps will be used to wash down all eight sludge tanks during each return trip. The requirements are that the vessel be capable of being loaded from shore installations within 2 hr, and gravity-unloaded at sea in less than 1/2 hr, twice a day. The characteristics and operation of the vessel are detailed.

68-0672

Dick, R. I. Thickening characteristics of activated sludge. Water Research, 2(1):91-94, Jan. 1968.

The 'non-ideal' behavior of activated sludge was interpreted in terms of the rheological properties of the suspension. It was hypothesized that the reason activated sludge failed to behave according to the prevailing theories of thickening, was that its flocculent nature and high volumetric concentration

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permitted formation of a continuous internal structure, even at ordinary mixed-liquor suspended solids concentrations. A conceptual model of the hypothesized mechanism of subsidence of activated sludge was developed, and the agreement between the general form of the mathematical models and observed settling behavior is illustrated. It was found that activated sludges from a variety of waste treatment plants were found to behave as plastic materials. They possessed finite yield strengths at normal, mixed-liquor suspended solids concentrations, and the magnitude of the yield strength depended upon the conditions under which the sludge was developed. The relative magnitude of the interparticle force, as computed from laboratory settling data by use of the mathematical models, was also shown to be related to the yield strength of the same sludge, as determined by use of the viscometer. The work confirms that the 'ideal' thickening theories are not strictly applicable. Contrary to these theories, the area of the thickening portion of a settling basin need not be considered inalterably established by the settling velocity of the rate-limiting concentration of activated sludge. Activated sludge does not conform to the prevailing theories because it exists as a plastic material even at the relatively low concentrations at which it enters sedimentation basins. Thus the area required for thickening can be reduced, or the capacity of an existing basin can be increased, by minimizing the reduction in settling velocity due to interparticle forces within the sludge.

68-0673

Dickinson, D. Problems of effluents from factories. *Food Manufacture*, 43(4):37-42, Apr. 1968.

Several routes followed by an industrial effluent on its way to the sea are outlined, and physical and biological treatment locations are mentioned. Specific cases in the food industry known to follow these various routes are considered. Particular emphasis is devoted to factory sites, with some suggestions regarding the location of new factories. Factory sites with direct access to the sea have advantages over inland sites. Facilities for effluent disposal should rank with availability of the waste supply when considering the location of a new factory.

68-0674

Digested sludge disposal on inaccessible farmland. *Surveyor and Municipal Engineer*, 132(3992):49, Dec. 6, 1968.

A tanker and pipeline were used to spray digested sludge in liquid form onto farmland. Recent trials were carried out in mixing grass seed with the sludge, and in using the technique to convert land into grazing pasture. The vehicle used was a 2,000-gal tank in a Commer chassis, equipped with an irrigation pump and a 4-in.-diameter flexible aluminum pipeline. Trials were repeated at various seasons of the year with both unprepared and prepared ground. It was concluded that where ground is inaccessible to normal farm implements, poor grazing areas can be substantially improved by this method. This method also has possible applications in the grassing over of slag tips.

68-0675

Disposing of domestic waste biologically. *Science Journal*, 4(2):21-22, Feb. 1968.

A waste disposal system, based on biological decomposition and fully independent of the water and sewer networks, has

been developed by Rikard Lindstroem of Sweden. While intended for one-family houses in areas with insufficient provision for disposal of wastes, it can be adapted for camping or bathing sites, military training stations, and agricultural establishments. The system consists of a garbage chute from the kitchen and a toilet which requires no flushing, both of which are connected via vertical pipes to a decomposition chamber made of a reinforced impermeable plastic material situated in the cellar or partially buried outside. The waste material decomposes biologically at the top of the chamber, water vapor and carbon dioxide escape via an exhaust duct, and the final products, which can be used as fertilizer, accumulate in the form of salts and humus in the lower part of the container.

68-0676

Dudley, R. H. Grit handling at Kokomo. *Water and Sewage Works*, 115(3):127-128, Mar. 1968.

Grit at the Kokomo, Indiana, sewage treatment plant is handled in a totally enclosed tubular grit conveyor which may be operated out-of-doors without freezing. Simple, inexpensive heating cables are wrapped around the conveyor casings. One-inch asbestos insulation, a final outside coat of mastic, and a finish coat of paint, complete the weatherproofing. Grit is exposed only at the discharge point, and regularly scheduled dumping has eliminated odor problems. Pushers, composed of a specially compounded neoprene to resist abrasion, after traveling some 500 miles and carrying nearly 1/2 million lb of grit, show no significant loss in size. The chain lift components are all made from hardened steel, and an O-ring seal arrangement effectively seals the pin bearing area from abrasive materials. A patented, single pin, flexing arrangement results in 50 percent fewer pins than in conventional chains, and total elongation after a year of operation amounts to an in. or less. Safety factors include: completely enclosed system, totally enclosed guards on the V-belt, and roller chain drive assemblies.

68-0677

Dumbleton, B. M. New activated sludge plant to serve three Warwickshire villages. *Surveyor and Municipal Engineer*, 132(3972):31-33, July 1968.

An activated sludge plant to serve three Warwickshire villages, with an ultimate population of 6,000, is being constructed. Composite samples of crude sewage were taken over an 8-hr period, and the results indicated a BOD figure varying from 280 to 900, and a suspended solids figure varying from 214 to 1,380 ppm, with an average pH of 7. Storm tanks, with a capacity of 120,000 gal, were constructed. The sewage is screened, passes through a measuring flume to a distribution chamber, and into two circular primary settlement tanks with a total capacity of 60,000 gal. The tanks are scraped by mechanical half bridge scrapers. After a period of 9 hr in the aeration tanks, the activated sludge, mixed with primary sludge, is discharged into two-stage cold sludge digestion tanks with a capacity equivalent to 5 cu ft per head of population served. The effluent is passed to secondary settlement tanks, and the final effluent discharged into a brook near the plant. The sludge tanks have a total capacity of 60,000 cu ft and are equipped with compressed air circulating equipment. Digested sludge is transferred by gravity to the drying beds having an area equivalent to 5 persons per sq yd, and from there the sludge is carried by

conveyor to a trailer for storage or tipping. Decanted water from the digestion tanks and drainage from the sludge beds is recycled.

68-0678

Fales, R. Electrolyzed seawater plays a big role in sewage disposal method. *Chemical Engineering*, 75(13):172-174, June 17, 1968.

The use of electrolyzed seawater to treat sewage, a method originally utilized by CJB Process Ltd. (London, England), has since undergone changes, resulting in lower costs and more efficient processing. CJB's first plant at Guernsey still operates by sterilizing raw sewage with a dose of electrolyzed seawater. The eight original open cells have been replaced by four compact closed cells, which have reduced electrolysis costs 50 percent. Processing time has been halved and production costs reduced. The Guernsey plant handles an average of 6,000 gal of raw sewage per hr. The raw material is screened, passing through disintegrators that reduce particle size to less than 0.125 in. A continuous flow of seawater is pumped to a storage tank. A 6-v. direct current is supplied to the plates. Cell products consist of chemicals such as hypochlorites and hypobromites which react with ammonia, amino acid residues, and dissolved nitrogenous substances in the sewage to produce chloramines and chloramine-like compounds which function as sterilants. The sewage-to-seawater ratio is normally about 60:1. An active-chlorine analyzer has been installed to measure the strength of the sewage. The sterile effluent, having an E. coli content of not more than 200 per ml, is discharged into the ocean. The complete process cycle takes about 30 minutes. Typical costs are given. The U.K.'s Electricity Council is exploring the possibility of adapting the electrolytic system to inland towns.

68-0679

Eckenfelder, W. W., and L. F. Tischler. Linear substrate removal in the activated sludge process. *Water Research*, 2(1):54-58, Jan. 1968.

Since it is believed that the transport of substrate into a microbial cell is an enzymatic phenomenon, the Michaelis model appears to offer a good method of describing the removal of an organic substrate from solution by a microbial population. The Michaelis-Menton equation predicts that when the substrate concentration is high enough, the removal rate will be at a constant, maximum value, i.e. independent of the substrate concentration. The objects of this investigation were: to demonstrate zero order removal of several simple organic compounds by a mixed population activated sludge; to observe the removal rates of these organics in terms of the laboratory and field parameters in use today; and to show that the summation of the COD removals of each of the compounds alone will give the overall COD removal of a unit containing a mixture of the organics in the same initial concentrations. The studies have evaluated the effect of common laboratory and field parameters on the removal rates of glucose, aniline, and phenol. The organic loading to the continuous unit was varied in order to change the character of the acclimated sludge. At high loadings (1.0 lb COD per lb MLVSS per day), filamentous sludge predominates, and results indicate that the removal rate per unit mass of sludge is unaffected. At lower loading levels the

sludge formed a good settling floc, typical of that found in a well-operated activated sludge process. The effect of biological solids level on the removal rates of the three compounds by a given sludge was also studied.

68-0680

Economic sludge dehydration with a traveling screen press. *Wasser Luft und Betrieb*, 12(10):646, Oct. 1968.

For dehydrating sludges, the traveling screen press proved to be very useful. The sludge from the purification tanks is mixed with synthetic flocculants and continuously dehydrated between screen and press. Pressure and speed of the traveling screen can be adjusted. A coarse screen is used to avoid clogging. An automatic flusher cleans the screen. The operating costs of the dehydration plant are low, because almost no personnel is required. Apart from transporting the dry filter cakes, the flocculants must be prepared once a day, which takes about 15 to 60 minutes. During the rest of the time the plant is monitored by automatic control equipment, which indicates all problems, and switches off the plant automatically. The plant can be switched on and off by a time clock. All movable parts are made of plastic material or steel. The speed of the screen is low so that wear and tear is no problem. (Text in German)

68-0681

Edwards, G. E., and W. R. Gadsden. Dewatering of flotation tailings by filtration or centrifuging. *Australian Mining*, 60(10):41-43, Oct. 15, 1968.

Flotation cleaning of the fine coal fraction (minus 30 mesh) has extended rapidly in washeries. A major problem of the flotation operation is disposal of the tailings, which are almost invariably finely divided and in pulp form. Dumping beyond the continental shelf 14 miles at sea was considered, but the possibility of pipeline blockages or of currents returning some tailings to the shoreline made the proposal unsuitable. Mixing of thickened tailings with crushed refuse was examined, but the product was unsuitable as fill. Roll discharge filtration offers a practical alternative to dams when the latter can no longer be operated. Solid bowl centrifuging at high centrifugal force is another alternative. Filter pressing would be the most positive solution, but it is considered the last resort.

68-0682

Effluent from three mills and city treated successfully. *Canadian Pulp and Paper Industry*, 21(8):49-51, Aug. 1968.

A pilot plant to treat the waste from the City of Plattsburgh, New York, a groundwood mill manufacturing molded fiber containers, a tissue mill, and a wallpaper manufacturing plant demonstrated that the conventional activated sludge process can be used successfully in this situation. To duplicate actual operation, waste from these sources was blended in proportion to the source. Laboratory tests showed that the effluent was amenable to biological treatment, and that an effluent low in BOD could be produced within a reasonable detention time. Primary settling was used throughout the pilot plant studies and averaged 26 percent BOD removal and 55 percent suspended solids removal. This was deemed necessary due to the high fiber content of the raw waste.

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From here the stream flowed to the aeration tank, at which point returned activated sludge from the secondary clarifier joined the waste stream. After 6 hr of biological oxidation, the flow proceeded to the final settling tank, where activated sludge was removed through sedimentation and returned to the aeration tank. A modification of the activated sludge process, which uses contact of the return activated sludge with the raw waste for a short period, followed by sedimentation, permits use of a smaller aeration tank volume by utilizing the initial removal capacity of stabilized sludge. Called contact stabilization, the method produced the desired degree of BOD removal with a contact time of 3 hr with the combined waste flow. With the contact period this long, the contact stabilization process provided no significant economic advantage over activated sludge.

68-0683

Electrolysis-bred bubbles clarify water. *Chemical Engineering*, 75(16):82, July 29, 1968.

Already having overcome a water pollution problem for the French steel industry, a continuous separation technique promises to speed the removal of insoluble suspended matter from other waste water streams at costs lower than present techniques and in applications where removal was previously unfeasible. Called Electroflotation, the method works by electrolyzing water in the stream, and using the resultant gas bubbles to carry particles to the surface where they are mechanically removed. The cost is only 0.035 cent per cu ft compared with about 3 cents per cu ft for previous methods. A plant in Thionville, France, treats 75 cu m per hr of effluent in 10 parallel cells. Incoming effluent contains between 150 and 300 mg per liter of solid material, and 300 to 600 mg per liter oil. Outgoing treated water has less than 30 mg per liter solids, and less than 40 mg per liter oil. Electroflotation yields bubble diameters generally 0.1 mm or less. The bubbles' tendency to coalesce after separating from the electrode is low—so they stay the same size as they travel through the liquid. Flow around each bubble is laminar, lessening localized disturbances and mixing.

68-0684

Enders, K. E., J. Hammer, and C. L. Weber. Anaerobic lagoon treatment of slaughterhouse waste. *Water and Sewage Works*, 115(6):283-288, June 1968.

The waste flow of an abattoir in rural northeastern Nebraska is pumped to a lagoon treatment system consisting of first-stage anaerobic lagoons, followed by intermediate and secondary aerobic lagoons. The results of extensive testing indicated that anaerobic lagoons are feasible for the first stage treatment of slaughterhouse wastes in rural locations. If designed in accordance with accepted practice, the lagoons have the capacity to handle shock loads and intermittent loadings without significant loss of treatment efficiency. Under conditions existing during the studies, BOD removal in the anaerobic lagoons was greater than 80 percent. The solids buildup in an anaerobic lagoon system, given preliminary treatment for removal of paunch manure and recovery of by-products, seems to be extremely low. The primary bacterial activity in an anaerobic lagoon is similar to that of conventional digestion, i.e. the conversion of volatile solids to gaseous end products.

68-0685

Expo 67 sewage treatment plant. *Water and Sewage Works*, 115(1):49-50, Jan. 1968.

A sewage treatment plant constructed at Montreal's Expo 67 removed a minimum of 90 percent of the BOD and suspended solids from incoming sewage with a maximum capacity of 3.5 million gal per day. A battery of 496 'aeration guns' is the main element in a relatively new process called 'aerohydraulics.' Anchored beneath the 20-ft-deep waters of the treatment pond, the guns, 12-in.-diameter polyethylene stack pipes, were used for aeration, sludge movement, and separation of the pond into different zones. The only mechanical units in the system are four 7CDL-17 Gardner-Denver cycle blower units, each of which supplied 1,970 cu ft of air at 15 psi to the guns. Sludge return guns (56 in all) direct organic matter, that has settled out, back into the aeration zone.

68-0686

Ewing, R. C. Refinery waste products pose pollution problem. *Oil and Gas Journal*, 66(50):77-82, Dec. 9, 1968.

The wide variety of pollutants generally present in refinery waste streams are considered, including chromates, caustic cleaning agents, phenols and cyanide, oily wastes, hydrogen sulfide, coke, gums, and catalyst fines. Methods of removing each of these impurities are specified. Oily waste water streams, after passing through the oil removal system, always require further treatment, which is usually biological in nature; for example, lagoons and activated sludge units. Systems including activated sludge, fluidized bed incineration, and ultrasonic incineration are described. Disposal of oil-coated solids is being handled through experimental application to land, where it is hoped that some enrichment of the soil will occur. Time, depth, and spacing of applications are under study. Deep well disposal of wastes is being used, but there are limits to this method due to the nature of the wastes themselves and problems with subsurface water.

68-0687

Eye, J. D., and S. P. Graef. Pilot plant studies on the treatment of beamhouse wastes from a sole leather tannery. *Journal of the American Leather Chemists Association*, 63(6):396-409, June 1968.

The wastes from the beamhouse of a sole leather tannery were separated into lime-bearing and non-lime-bearing fractions. The lime-bearing wastes were treated with an anionic polyelectrolyte and clarified by settling. The clarified wastes were then blended with the non-lime-bearing waste fractions and neutralized to a pH of about 8.5. The blended wastes were treated in a stratified anaerobic-aerobic biological system for reduction of the organic components. The COD and suspended solids of the waste were reduced 90 to 95 percent in the pilot plant. The results of the pilot plant study were used to design a full scale treatment plant capable of treating 150,000 gal of waste per day. The full scale system included: changes in the plant sewers; a vibratory screen; two waste water sumps complete with pumps; a polyelectrolyte feeding and mixing unit; a 10,000-gal upflow clarifier; sludge removal piping and pump; two lagoons, 100

ft sq and 14 ft deep, and a floating aerator for the primary lagoon.

68-0686

Farkas, P. Method for measuring the aerobic activity of activated sludge in an open system. *Water Research*, 2(1):47-52, Jan. 1968.

The use of this method, in an environment approximating nature, makes it possible to determine to what degree the various chemical and physical factors affect the decomposition rate of organic matter. From the decomposition rate, conclusions are drawn regarding the amount of active bacteria in the sludge. In sludge samples, adjusted by dilution to a predetermined concentration, the time needed for acetate removal was found to be inversely proportional to the sludge concentration. In systems fed by equal successive charges, the measurements indicate higher bacterial growth rates at lower initial sludge concentrations than in systems at increased initial sludge concentrations. In cases where activated sludge grown on domestic sewage has been loaded successively with industrial wastes, it was observed from the successive shortening or prolonging of the time needed for decomposition, that either adaptation or toxic effects occurred. With industrial wastes of complex composition, the method does not yield results which show the oxygen uptake caused by the different constituents of the waste. It was found that the characteristics of the respiration curves of pure compounds could be identified even in the complex respiration curves of their mixtures. In such cases, the activity of each constituent could be determined individually. Attempts were made at determining the nitrogen and phosphorus requirements for chemically homogeneous, organic substances and for industrial wastes by recording respiration curves. With the procedure described, bacterial growth could be followed, together with the measurement of the respiration process. Evidence is presented for the dependence of growth rate on the state of nitrogen and phosphorus supply.

68-0689

Filter press. *Wasser, Luft und Betrieb*, 12(10):648, Oct. 1968.

Filter presses are used for the removal of impurities such as sludge, soot, and suspended particles. Their advantages are robust construction, simple cleaning and replacement of the filtering tissues or papers, and continuous operation when two presses are connected in parallel. The filter presses on display at the Hannover fair, manufactured by A. Hering AG, reach a pressure of up to 6 kg per sq cm. The panels, plates, etc. of the filter presses are made of high quality cast iron. All parts which come in contact with corrosive liquids can be made of silumin, copper, or plastic. (Text in German)

68-0690

Fire fighting contractors level mountains of burning coal waste. *Construction Methods and Equipment*, 50(3):64-67, Mar. 1968.

Two methods were used by two contractors to cut down and level mountainous heights of burning waste materials, heaped

during past coal processing operations in Pennsylvania. One of the contractors cut and extinguished fires with jet streams of water, draglines, scrapers, and dozers. The other contractor bored horizontal holes in the material, shot it, soaked it with water, and then dozed it away. Both methods successfully put out the fires.

68-0691

Fomin, S. P., and K. B. Khait. The use of biological ponds for sewage treatment in Central Kazakhstan. (Karaganda Medical Institute). *Hygiene and Sanitation*, 33(7-9):290-291, July/Sept. 1968.

The efficacy of biological ponds for domestic sewage treatment at the settlement of Maikuduk was studied in 1963. The multistage biological ponds with nine consecutive sections, flowing water, and without dilution by clean water, are described. The average quantity of domestic sewage reaching the pond daily is 7,500 cu m. The sewage takes about eight weeks to pass through all the sections. It remains in each section for a period varying from 4 to 8 days. Observations on the operation of the ponds were carried out from the beginning of April until December 1966 (from the time the ice on the ponds melted until they froze again). The total number of tests was 1,530, and the results were statistically analyzed. Under the climatic conditions of Karaganda, situated in the first climatic zone, the self-purification of sewage is fairly efficient during the 6 to 7 months of the year after the middle of April. The efficiency increases in the following month, reaching a maximum in August. It decreases in the middle of November, when it returns to the April level. The oxidation of organic substances almost ceases after the ponds become frozen. The self-purification is highly efficient in the first five sections, so that a large number of sections is not required. After treatment in the biological ponds, the sewage is bacteriologically safe and can be used to irrigate cultivated land.

68-0692

Forster, C. F. The surface of activated sludge particles in relation to their settling characteristics. *Water Research*, 2(11):767-776, Nov. 1968.

Very little work has been reported which relates the surface properties of sewage sludges to their dewatering characteristics. Therefore, the measurement of the electrophoretic mobility of activated sludge particles was included in the analysis of routine samples from a Lubeck pilot plant. These measurements were made in a rectangular cell of the type described by James (1957). In constant ionic strength buffer solutions (I equals 0.2), no correlation was found between either the isoelectric points of the pK values of the sludge surfaces or the sludge volume index. Mobility measurements of the sludge particles in their own liquor, however, showed that the average mobility was directly proportional to the sludge volume index, which in turn was a logarithmic function of the ratio of ammonia-nitrogen to soluble phosphate in the liquors. This would appear to indicate that the settling characteristics of activated sludges are governed by some metabolic process which can alter the nature of the surface of the sludge particles. Supporting data are included.

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68-0693

Forstner, Von M. J. The influence of waste water, water-borne manure and composting on the viability of parasitic growth stages. *Zeitschrift fuer Wasser und Abwasser Forschung*, 3(6):176-184, Nov.-Dec. 1968.

For 1½ to 2 hours during the preliminary clarification of waste water, helminth ova can be concentrated in the sewage sludge due to sedimentation. Waste water can thereby be freed from worm eggs. The annihilation of the very resistant ova of *Ascarides* and *Taeniae*, which survive subsequent sludge digestion, can only be guaranteed by high-temperature procedures. Agricultural utilization of digested sludge is possible if the fertilization is done in autumn on fields used for the cultivation of potatoes or cereals, because these crops will only be eaten or fed after cooking or frying. Sludge from activated sludge plants constantly contains viable ova of parasitic worms, and therefore its application is only possible after pasteurizing or composting. In excrement, helminth ova die after the manure is piled for 2 months, just as they are destroyed after 2 months in liquid manure. Not all parasitic stages are killed after 85 days in the gulley hole of waterborne systems of manuring, due to the presence of water. Grass fertilized with manure can be satisfactorily fed after 80 to 90 days in a silo. Material infected with worm eggs, such as offal, parts of manure, etc., have to be removed by composting. By the common composting of sewage sludge and garbage, a hygienic and unobjectionable product can be obtained. (Text in German)

68-0694

14,000 kw from sewage gas. *Diesel and Gas Turbine Progress*, 34(1):20-21, Jan. 1968.

The largest treatment center proposed in a master water pollution control plant for the City of New York, located in the Greenpoint section of Brooklyn, is the Newtown Creek water pollution control plant. The plant will treat an average flow of 310 million gal per day of combined sewage, utilizing the 'high rate' activated sludge process, which detains the sewage 1.5 hours at average flow rates. The treatment process includes grit removal, aeration, settling, and hypochlorination. The settled waste sludge is thickened, anaerobically digested, and disposed of at sea by a fleet of sludge vessels. The same process results in the production of sludge gas, a mixture of roughly 40 percent carbon dioxide and 60 percent methane, which is used as fuel for the dual fuel engine-generators. The heat value of the sludge gas is approximately 600 Btu per cu ft. Heat recovered from the engine cooling water is used for heating the sludge contents of the digestion tanks, thus maintaining the optimum 95 F temperature favorable for the sludge digestion process.

68-0695

Gale, R. S. Some aspects of the mechanical dewatering of sewage sludges. *Filtration and Separation*, 5(2):133-148, Mar.-Apr. 1968.

A brief outline of sewage treatment methods, the concentrations and quantities of solids involved, and comments on the differences in quantities and properties of sludges from various sewage works is presented. Performance data include type of sludge, conditioning, solids content, and

output; these are tabulated for the vacuum filtration, filter pressing, and sludge concentrators methods of dewatering sludge. These data show that sludges are not easy to dewater, and that conditioning is a crucial aspect to the operation. The amount of conditioner used and the conditions of its application, including stirring and aging of the sludge, are discussed. Drawings and tables illustrating effects of stirring, quantity, and time involved are included.

68-0696

Gates, C. D., and R. F. McDermott. Characterization and conditioning water treatment plant sludge. *Journal of the American Water Works Association*, 60(3):331-344, Mar. 1968.

Wastes removed at rapid sand filtration plants include mixtures of soil, microorganisms, organic chemicals, and hydrous oxides that accumulate at the bottom of settling basins, as well as finer fractions of the same mixtures collected at the filtering medium of the basin. These wastes, which are removed hydraulically, are commonly discharged without treatment to nearby bodies of water and often pollute the receiving water. A study of solid contents, settleability and filterability of the alum sludge in two water treatment plants was made with the aid of specially designed in-place samplers (shown on schematic drawings). Bottom samples, after draining, showed an average concentration of 40,900 mg per liter. Studies of settleability, carried out in 1-liter graduated cylinders, showed a distinct interface between the supernatant and the settling solids ('zone settling'). In filterability tests, a 9 cm ceramic Buchner funnel, a 100-ml sample volume, and a negative pressure of 15 in. of mercury were used with No. 5 Whatman paper filter medium. Specific resistance ranged from one billion to 4.4 billion sq seconds per g. Additional investigations concerned viscosity, volatile solids, and the use of polyelectrolytes for conditioning of the alum sludge. Approximately 95 percent of the total solids in the sludge were found to be settleable solids, while further studies are suggested on the applicability of the reported alum sludge characteristics.

68-0697

Gaudy, A. F., K. C. Goel, and A. J. Freedman. The treatment of sugar refinery waste by a new modification of the activated sludge process. *Water Research*, 2(1):90, Jan. 1968.

A recently developed modification of the activated sludge process, reducing the nitrogen supplement for nitrogen-deficient wastes and preventing a leakage of nitrogen to the receiving stream, is tested on a continuous flow basis, employing whole waste. A continuous flow pilot plant was operated in accordance with the flow diagram already proposed. Sugar refinery effluent, essentially devoid of nitrogen, was employed; the average COD of the waste was approximately 850 mg per liter and its BOD 500 mg per liter. Approximately 45 percent of the COD registered as carbohydrate. During the study the COD concentration varied approximately plus or minus 35 percent, permitting the opportunity of examining the stability of the system. (In initial experiments, phosphate buffer was added to the waste.) It has been found that the process yields in excess of 90 percent COD removal, using detention times in the feeding aerator as low as 5 hr. The detention time used so far

in the endogenous aerator has been 1.2 hr, although it has been determined that conversion occurs within 7 hr. Throughout the study the sludge exhibited excellent settling characteristics. Research is now continuing in order to optimize detention times, air flow rates, etc. It was concluded that the new modification of the activated sludge process, which was proposed on the basis of batch studies using synthetic waste, can be usefully employed for the treatment of the whole waste used under continuous flow conditions.

68-0698

Gavelin, G. Is evaporation the ultimate solution to effluent problems? Paper Trade Journal, 152(24):102-103, June 10, 1968.

In pulp and paper mills, the objective is not to reclaim clean water, but to concentrate the dissolved solids in the waste water to a stage where they can be economically thickened by evaporation. Although effluent evaporation is normally considered economically unfeasible, a Swedish mill located at Skinnskatteberg has obtained satisfactory results. The effluent water was divided into three separate systems: cooling water and seal water is piped directly to the sewer; water collected from the fresh water showers goes to a lagoon; while excess water, water pressed out at the defibrator screw presses, and all other contaminated effluents are collected in tanks and pumped to filters. The filtered water is drawn to the evaporating plant. Tank overflows are recirculated. It was possible to bring the total dissolved and colloidal solids content of the water to 3.8 percent, which is a comparatively low load on the evaporating plant. Operation of the evaporating plant is discussed. Steam consumption is 700 lb at 25 psi per metric ton of water evaporated. Cost of evaporation is calculated to be \$0.75 per ton of board. The process of reverse osmosis is also discussed.

68-0699

Gerstenberg, H., and H. Schafer. Mechanical dehydration. Chemie-Ingenieur-Technik, 40(7):359-361, May 1968.

The work group, 'mechanical dehydration,' of the Association of German Engineers (Verein Deutscher Ingenieure) held a meeting on October 24 and 25, 1967 in Freiburg, West Germany. One paper dealt with flow and movement in decanter centrifuges. In direct current decanters, solids and liquids flow in the same direction. At a rotation of less than 3,000 per minute, no satisfactory dehydration is achieved. The second paper dealt with a filter dehydrator. Contrary to the conventional cake filtration, the polluted water to be filtered flows at high speed past the filter dehydrator, so that no cake can form. With a dense, smooth polypropylene tissue, no clogging occurred even at a low speed of 1 m per sec, but a lower amount of solids were retained. Kaolin-containing water could be thickened from 50 g per liter to 300 g per liter. The work group 'disposal of industrial wastes' of the Dechema Association held three meetings when members of the work group 'mechanical dehydration' were present. To them, the paper 'Disposal of municipal and industrial waste water sludge according to the Passavant sludge/ash method' was of special interest. With this method, part of the ash is directly mixed into the sludge to improve its dehydration ability; the rest is applied to the filter tissues (thickness 0.2 to 0.5mm). In another paper,

filters with built-in pressure membranes were discussed. With those, considerably better dehydration results can be achieved. Another paper discussed special corrosion problems. By using corrosion-proof coatings, (such as rubber, galvanic protective coating, etc.) abrasive corrosion can be stemmed. Another paper dealt with dehydrators and centrifuges in the potassium plant of Buggingen, Germany. The development of hydrocyclones in the kaolin industry was illustrated by slides. The new hydrocyclones of the Amberg kaolin plant were described. (Text in German)

68-0700

Gibbs, W. R., and H. Benjes. Design and operation of a combined waste treatment plant. Public Works, 99(2):66-70, 121, Feb. 1968.

Studies were undertaken in 1962 to determine the best approach to solve the present and anticipated problems of waste treatment in Grand Island, Nebraska. Aerobic lagoons, anaerobic lagoons, trickling filters, and several variations of the activated sludge process were investigated. The studies led to the decision that maximum efficiency and economy would be realized by combined treatment of domestic and industrial wastes in a new plant incorporating the complete-mixing activated sludge process. Lower operation and maintenance cost would result. Data charts and tables from the operation of the new combined facilities are included. A complete layout of the plant, as well as special and conventional equipment, total costs, and operation of the facility are discussed.

68-0701

Gratteau, J. C., and R. I. Dick. Activated sludge suspended solids determinations. Water and Sewage Works, 115(10):468-472, Oct. 1968.

Methods tested for determining activated sludge suspended solids concentrations within the range of values ordinarily found in waste treatment plants included: Gooch crucible asbestos mat, Gooch crucible-glass fiber filter, membrane filter-oven dried, and membrane filter-dessicator dried. The methods were compared with respect to accuracy, precision, convenience, and cost. The methods used for the determinations are detailed, and the results suggest that the glass fiber filter-Gooch crucible method is comparable or superior to the other methods. The glass fiber filter method was found to be the most accurate, and its precision was comparable to the membrane filter technique. It was also the most convenient and economical. The membrane filter technique is the most precise of the methods examined. The asbestos mat-Gooch crucible technique was found to be the least accurate and most imprecise method investigated, and was judged most inconvenient.

68-0702

Greer, W. T. Sea disposal of sludge at Glasgow. Water Pollution Control, 67(4):431-432, 1968.

Sludge from the main at Dalmarnock, and tanked-in sludge from neighboring authorities, is lifted into elevated storage tanks by centrifugal pumps. Two tanks are used, each divided into two compartments, each holding about 1,450 tons. The

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tanks discharge into a ship making use of an available hydraulic head which varies according to the state of the tide and the depth in the elevated storage tanks. The sludge is divided in the ship's hopper into four equal streams so that the ship's four cargo tanks are loaded simultaneously. The dump is in the Firth of Clyde, and is discharged through manually opened, mushroom-type valves. The sludge is discharged, without pumping, in approximately 10 minutes. The total shipped to sea in 1966-1967 was 809,551 tons. The cost averages 18S. 13d. per ton.

68-0703

Gregorieva, L. V., G. I. Korchak, and V. I. Bondarenko. Sanitary characteristics (virological and bacteriological) of sewage, sludge, and soil in suburbs of Kiev. *Hygiene and Sanitation*, 33(7-9): 360-365, July-Sept. 1968.

Virological and bacteriological investigations of sewage, sludge, and soil in the Bortnichi sewage treatment installations in the suburbs of Kiev, together with survival studies of certain microorganisms in the sludge, which was a mixture of sediments from primary settling tanks and excess activated sludge, were carried out in 1965-1966. The sewage was analyzed throughout the year in the different stages of its mechanical-biological processing. Sludge samples were similarly taken from methanol tanks, before and after thermophilic fermentation. The soil irrigated with the sewage was studied on 11 plots, with various agricultural crops, from March through October of each year. These plots were irrigated with a mixture of household sewage and industrial effluents after complete biological processing in some cases, and after only mechanical processing in others. Of the 11 plots investigated, two were used as controls; these were irrigated with water from a drilled well. The samples of sewage, sludge, and soil were tested for the presence of enteroviruses, coliform bacteriophages, pathogenic serotypes of *E. coli*, sanitary-bacteriological indices, and total microbial contamination. Supporting data are furnished. Survival studies of pathogenic microorganisms in the sewage sludge revealed a fairly prolonged viability, both on storage and under various fermentation conditions.

68-0704

Greiner, F. J. Dairy industry and environmental waste. *Journal of Dairy Science*, 51(7):1,151-1,153, July, 1968.

Earlier this year, the Dairy Industry Committee, composed of the operating executives of the dairy associations at the national level, established a new Environmental Waste Subcommittee. The subcommittee is analyzing new air and water pollution legislation and determining its effect upon the dairy industry. Aluminum, plastic, and glass nonreturnable containers have great consumer convenience, but they do represent serious solid waste management problems. Those which may be incinerated may contribute to air pollution. Those which must be disposed of on land remain in our environment for centuries. One of the critical areas that should be examined by the dairy industry is waste prevention. Valuable materials can be recovered from industrial effluent. Present techniques in the production of cottage cheese provide waste water with a minimum of 20 percent of whey solids. An improved method of separating the curd from the whey to obtain a better recovery of the whey would permit a big reduction in waste from cheese

plants. Effective reuse of waste water, and alternate waste treatment methods in milk plants and dairy farms must be considered.

68-0705

Griffiths, J. Control and treatment of trade effluents. *Surveyor and Municipal Engineer*, 131(3956):22-25, Mar. 1968.

Control of trade effluents entering public sewers is necessary so that the sewers will not be blocked, damaged, or rendered dangerous or a nuisance. The degree to which the effluents must be controlled is governed by river authorities and local authorities. The amount of control varies with the situation existing in the local area, the nature of the effluent, and the volumes of trade effluent and sewage to be treated. Solids, grease and oil, high volume discharge, pH, temperature, petrol, and oil contaminants generally require some pretreatment or control before discharge into sewers. A charge to the producers of the waste is in some cases necessary, especially when the treatment facilities must be considerably larger or more complex to treat the trade wastes. A high degree of cooperation is necessary between industry and local river authorities to handle this problem.

68-0706

Hammer, M. J., and T. Tilsworth. Field evaluation of a high rate activated sludge system. *Water and Sewage Works*, 115(6):261-266, June 1968.

A high rate activated sludge system was selected for Wahoo, Nebraska, to treat the sewage from nearly 4,000 inhabitants. The population is expected to increase to 7,500 by 1980, at which time the design flow of 1.75 million gal per day, having 290 mg per liter BOD, is expected to be realized. The plant was designed on a symmetrical basis consisting of two complete, independent, aeration units and aerobic digesters. At the time of the study, one-half of the plant was treating the entire sewage flow, which averaged 0.46 million gal per day on weekdays during June and July. Included among the tabulated data are: BOD characteristics of 24-hour composite raw sewage samples; BOD and solids data on 24-hr composite plant influent; effluent samples, maximum and minimum hourly loading rates, and retention times; characteristics of mixed liquor in aeration tank; quantity and characteristics of excess activated sludge pumped from the aeration system to the aerobic digester; and design parameters versus observed values. The system performed satisfactorily at design loads, but cannot absorb significant daily overloads. The design air capacity, required to meet the peak oxygen demand during the maximum BOD loading period, was approximately 2,000 cu ft per lb BOD applied.

68-0707

Hanks, F. J., J. R. Lambert, and P. S. Opliger. Hydrologic and quality effects of disposal of peach cannery waste. *Transactions of the American Society of Agricultural Engineers*, 11(1):90-93 Jan.-Feb. 1968.

Since food processing is often highly seasonal, the disposal of its wastes by municipal sewage treatment plants can severely disrupt normal processes unless special arrangements are made. One of the most feasible methods of treating waste

water from peach canneries is to spread it on the soil surface. The intermittent application, for a short duration, would allow ample time between seasons for degradation of the solids. The infiltration rate and other hydrologic factors must be known for optimal use of the soil mantle. Also, the capacity for removal of such materials by the soil should be known. For this reason, lysimeters were set up on relatively undisturbed Cecil sandy clay loam. The results indicated that application of screened peach cannery waste on this type of soil is a satisfactory method of disposal. Common Bermuda grass is a suitable cover crop for this purpose, provided that an excessive hydraulic loading is avoided. The ability of the soil mantle to reduce BOD, alkalinity, pH, and suspended solids varied with the application rate. These factors did not significantly change in time under the conditions and durations used in the experiment. Evapotranspiration is a major factor in disposal of waste waters, and it approached computed potential values when application rates were around 0.50 to 0.75 times the amount which infiltrated under ponded conditions.

68-0708

Harrison, J., and H. R. Bungay. Heat syneresis of sewage sludges. Part I. Pilot plant tests with various domestic sludges. *Water and Sewage Works*, 115(5): 217-220, May 1968.

The use of heat to dewater municipal sewage sludge is a promising alternative to anaerobic digesters, because all organisms are killed, and the sludge can be considered for totally nonpathogenic fertilizer, landfill, or fuel. Pilot tests with various domestic sludges, which are detailed, showed that for Waring blended primary sludges, filtration improvement required both heating and holding. The filtration rate increased markedly with treatment temperature up to about 170°C and with holding time up to 20 minutes, with no further improvement noted at higher temperature or longer time. Data and calculations for sludges from the primary sedimentation hoppers are given. Sludge mixtures containing trickling filter humus were unaffected by heat treatment, and showed considerable resistance to filtration. A 1:1 mixture of primary and activated sludge showed a dramatic improvement in filtration rate with this treatment. The treated sludges gave relatively dry cakes, which could be discharged from the filter with ease and had sufficient heating value to be considered as fuel or supplementary fuel.

68-0709

Harrison, J., H. R. Bungay, and A. M. Lord. Heat syneresis of sewage sludges. Part 2. Plant design and costs. *Water and Sewage Works*, 115(6): 268-273, June 1968.

A plant design and costs of operation are considered for a process of dewatering sewage sludges by heat treatment and filtration. Two systems are analyzed, one employing high-pressure sludge pumping and the other avoiding that necessity. The costs for each of these two systems are tabulated including: equipment description and reference, interest at 4 percent depreciation, operation, and maintenance. Diagrams of the proposed heating systems are given for both systems, along with detailed descriptions. It was concluded that the costs of treating sludges by heat syneresis and filtration are attractive compared with those for sludge digestion and drying beds. With additional savings in space, and production of a cake with fuel or fertilizer value,

the sludge heating process is deemed worthy of large-scale evaluation. The costs, considering 3,830 tons of dry solids processed per year, would be \$23.23 per ton without high-pressure pumping; utilizing high-pressure pumping, they would be \$19.04.

68-0710

Hartman, L., and G. Laubenberger. Influence of turbulence on the activity of activated sludge. *Journal of the Water Pollution Control Federation*, 40(4): 670-676, Apr. 1968.

To determine how the activity of free-floating bacterial colonies is influenced by turbulence, activated sludge was grown on a medium consisting of diluted Liebig's meat extract. Without washing, the sludge was aerated by compressed oxygen until supersaturation was reached. Aeration was continued for about 10 to 15 minutes while the mixed liquor was in circular movement. The results indicated that at high concentrations of organic material in the mixed liquor, the transport of oxygen from the environment to the cell surface is the rate-limiting link in the chain of biodegradation reactions. An increase of oxygen pressure also results in an increase of oxygen consumption by the flocs. Turbulence resulted in the breaking apart of the agglomerated flocs in the bacterial colonies, and the exchange of contact area between the bacteria and the environment. Both phenomena result in an increase of the oxygen uptake. Deflocculation starts while the fluid is still in laminar movement, and it extends to some degree into turbulent conditions. At Reynolds numbers of around 5,000, no further influence of water movement on the physical properties of the flocs seems to occur. The influence of turbulence on the change of contact layer between bacteria and water occurs mainly between Reynolds numbers of 5,000 and 9,000. In activated sludge plants treating effluents high in organics, the oxygen tension should be higher than normal plants. This should result in a higher degradation rate per time and sludge unit.

68-0711

Hartmann, L., and G. Laubenberger. Toxicity measurements in activated sludge. *Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers*, 94(SA2): 247-256, Apr. 1968.

Toxicity measurements have shown that the Michaelis-Menton model can be applied to describe the activity of activated sludge. Some toxic materials tend to have a largely competitive effect, while others are largely noncompetitive. Several types of activated sludge were used to study both the influences of sludge composition and sludge age. Increasing sludge age finally results in pure competitive inhibition or noncompetitive inhibition, depending on the nature of the toxic material (copper sulphate or bichromate). The effect of pH is a pure noncompetitive inhibition. The relationship between mineralization of sludge and its sensitivity to toxic substances is also shown.

68-0712

Harvey, E. H., and T. M. Devine. Bark fines removal and recovery system. *Pulp and Paper Magazine of Canada*, 69(19): 43, Oct. 4, 1968.

Because of the significant contribution made to the suspended solids in its mill effluent by bark fines, Abitibi

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Paper Company has installed a Centribed system and lagoon. The Centribed system handles a total water consumption of 3,000 gpm and mechanically recovers a large percentage of bark fines, while allowing the recirculation and reuse of partially-treated effluent to the barking drums. The lagoon (600 by 60 by 8 ft deep) allows settleable material from the Centribed effluent to concentrate at the bottom, with a retention time of 50 hr per 24-hr day. The Centribed system operates at an efficiency of 78 percent, and the lagoon removes bark fines with an efficiency of 85 to 90 percent, giving an overall efficiency of about 97 percent.

68-0713

Harvey, E. H., and T. M. Devine. Bark fines removal and recovery system. *Pulp and Paper Magazine of Canada*, 69(23):71-76, Dec. 6, 1968.

A system is described to accomplish the 2-fold objective of mechanically recovering a large percentage of bark fines from a wet debarking operation, and allowing recirculation and reuse of partially treated effluent to the barking drums. A Centribed system designed to process 3,000 gpm of bark effluent is fully described with complete and detailed drawings. Tabulations include: recorded data from the various points in the system including pressure, flow, and consistencies; and overall woodroom bark recovery. Bark is being removed at an efficiency of 99 percent. Bark fines are being removed by the Centribed system at an efficiency of 78 percent. The lagoon removes bark fines from the final effluent at an efficiency of 85 percent. Any further attempts to reduce the suspended solids content significantly would probably require the use of chemical coagulants. The Centribed system consists of a Centriclone, two Centripress drainers, four Hydraclarifiers, and a settling tank with a lagoon for removal of solids which escape the Centribed system.

68-0714

Holding, J. C. Experimental work on digested sludge pressing. *Water Pollution Control*, 67(5):528-535, 1968.

At the Cambridge works, experimental testing was conducted to determine the feasibility of using filter presses and a digested sludge process for extending the existing plant. This method was tested because disposal of the product was accomplished through local farmers, and the cake product was judged to make a more attractive product. Various conditioners were evaluated using an experimental small press loaned by the manufacturer, and the results are given. It was decided to use lime and copper as conditioning agents, and six 80-chamber pre-presses, each 51 in. square, producing 0.75 in. cakes, provided with PVD monofilament cloths, were also used. Hydrochloric acid was to be used for cleaning the cloths in situ. It was decided to use 0.75 in. cakes, since better results were consistently obtained with the thinner cake. The capacity is estimated at 33,000 gal per day of digested sludge containing 5 percent solids.

68-0715

Hopkins, G. J., and R. L. Jackson. Solids handling and disposal. *Public Works*, 99(1):67-70, Jan. 1968.

Sludge disposal from Kansas City's three sewage treatment plants is centralized at the Big Blue River Sewage Treatment

Plant. This raw sludge filtration and incineration system, which represents an investment of \$4,635,000, will dispose of the solids generated by an estimated population equivalent to 845,000 persons. The sludge processing and handling facilities include: sludge thickening tank, sludge holding tanks, sludge dewatering equipment, (8 continuous belt-type vacuum filters), incinerators, laboratory facilities, and metering equipment. The incineration equipment consists of three multiple-hearth furnaces. Scrubbers limit the emission of fly ash to a maximum of 0.5 lb of particulate matter per 1,000 lb of flue gases. After an extensive study, it was decided to use polyelectrolytes to aid in the dewatering of the sludge. The Missouri Water Pollution Board issued a conditional permit to discharge residual ash to the Big Blue River along with the plant effluent. Vacuum filter operating data and design conditions for sludge incinerators are tabulated.

68-0716

Horn, W. New waste water process doesn't pollute air. *Plant Engineering*, 22(1):82-83, Jan. 11, 1968.

The stench from three waste treatment lagoons of a papermaking plant was polluting the air in the neighboring community. A new waste treatment process, the Purifax process, partly financed by the Federal government, was tried for the first time in an industrial plant. By incorporating some of the older pollution control equipment into the overall process, the cost of the installation was held to \$500,000. The system consists of pumping waste water from the mill into two receiving tanks outside the treatment building. From there it goes to the new treating equipment which consists of a reactor where chlorine is added with turbulent mixing. Pumps circulate the sludge in the reactor, and completely mix it with the chlorine. Cycle time for complete oxidation is from 1 to 2 minutes. No heat is required, and pressures generated are less than 50 psi. From the reactor unit, waste water goes to a defoamer. After foam has been removed, water is pumped into a flocc tank, where lime is added to cut down the acidity of the water. The final stage is a settling tank, where sludge settles to the bottom and is later drawn off and pumped back into the mill for reuse in the papermaking operation. The daily discharge from the mill is about 2 million gal. Chemicals used in the new system cost about \$55,000 per year.

68-0717

How Golden Wonder makes effluent treatment pay. *Food Manufacture*, 43(4):33-36, Apr. 1968.

The effluent treatment plant built by the Wonder Crisp Co. turns out 20 tons per week of high grade potato starch. The effluent treatment operation is divided into two lines. One handles potato wash water and peelings, while the other is devoted to starch recovery. An electrically-controlled pneumatic system allows operation in three ways: fully automatic control; pushbutton automatic control; and remote manual control. The price received for the starch, while not entirely covering the cost of running the effluent plant, nevertheless goes a considerable way toward offsetting the cost of effluent disposal.

68-0718

How to cut chipper waste. *Pulp and Paper Magazine of Canada*, 69(10):55-56, May 1968.

It is estimated that a 1,000-ton-per-day mill may improve yearly operating profits by \$200,000 by optimum chipper performance. In accepting bids for chippers, specifications should cover log size, species, chip size, the maximum amount of waste acceptable, bearings, alloys in chipper disc forging, heat treatment of chipper disc during and after manufacture, and specifications for critical characteristics and tolerances. Differences in species require different machine settings, and all possible effort should be expended to segregate mill feed by species to increase chipper efficiency.

68-0719

Hunteanu, A., E. Cote, and C. Negulescu. Pilot plant tests on mechanical and biological treatment of waste waters from kraft-cellulose factories. *Water Research*, 2(1):63-66, Jan. 1968.

Results are reported of tests for the most suitable treatment of waste waters from kraft-cellulose factories, carried out in a semi-industrial pilot station (30 liters per second) over a period of 250 days. Methods and equipment are described for mechanical, biological, and sludge treatments. Mechanical treatment in suspensional or deep settling tanks led to hydraulic loadings 2-fold greater than in radial settling tanks with the same treatment efficiency. The effluents were also better. However, suspensional settling tanks are not recommended due to their tendency to foam and the possibility of flotation of suspended matter due to wide temperature variations characteristic of such waters. The sludge from mechanical treatment is not biologically decomposable. Dewatering on drained sand beds was satisfactory. The drained sludge can be lifted and removed after 4 to 5 days. The settled waste water is easy to treat by biological methods, provided it is first neutralized and supplemented with sufficient microbial mineral requirements. The activated sludge aeration plant can be fed the waste waters without the addition of sewage. High treatment efficiencies can be attained by intensive aeration, and a high concentration of activated sludge can be maintained with considerable organic loading of the plant. Activated sludge treatment gives satisfactory results at short aeration times, for partial treatment of the wastes. Phenol, in the waste water, is completely removed by this method. The sludge formed in the aeration tank has satisfactory settling characteristics, even for short aeration periods, and it is easily decomposed.

68-0720

Hyde, P. E. Costs of transporting wood mill residues. Corvallis, Oregon State University, School of Forestry Research Laboratory, Oct. 1968. 9 p.

Transportation is an essential element of any means of waste wood disposal. In evaluating the cost of disposal or utilization other than burning on the site, the cost of hauling must be considered. Wood waste will usually be hauled by truck. Rail hauls are economical for more than 80 miles, if

sidings and hauling equipment are available at both ends. Belt conveyors may meet some requirements, and pipeline conveyors are a remote possibility. Hauling requires a capital investment in storage and loading equipment by the supplier, in hauling equipment by the transporter, and in unloading or hauling equipment at the disposal site. Capital investment costs include interest on investment in land and equipment, depreciation, and taxes. Costs that vary directly with the weight and miles hauled are labor, fuel, and maintenance. Total transportation costs include the costs incurred at the mill, plus those of the hauler. The mill's total disposal costs consist of transportation costs, plus charges by the receiver for disposing the waste. Sample cost estimates are given for hauling waste by motor truck for various lengths of haul. These are compared to some current rates for truck and rail hauling. The most economical costs are achieved when equipment is used for the maximum number of hours each day. For two-shift operation on short hauls of 15 miles or less, hauling costs for waste bark and sawdust will be about \$0.028 per cu yd per mile.

68-0721

Hyde, P. E., and S. E. Corder. A preliminary study of disposal of wood and bark wastes by landfill. Corvallis, Oregon State University, School of Forestry Research Laboratory, Oct. 1968. 5 p.

Wood and bark wastes do not offer an attractive habitat for vermin. It would not be necessary to daily cover a landfill of wood and bark wastes with a soil cover, although periodic cover may be useful as a means of fire control. During a survey of Oregon sawmills and plywood plants in 1968, some mills were found to be using wood and bark fills to reclaim swampy or low-lying areas. To make a realistic estimate of cost for landfill disposal of sawdust and bark, it would be necessary to select a particular location and set of conditions. Site factors such as availability, topography, land cost, distance from mill or mills, and subsequent use of the land would need to be evaluated. Based on the reported costs of sanitary landfills, a figure of \$1.25 per ton might be a first approximation of landfill costs for sawdust and bark. Less earth cover would be required, but less compaction would be expected, so that larger volumes would be required per ton of material. These two factors might tend to balance the cost. Truck transport of bark and sawdust for a 5-to-10-mile haul to the landfill would cost \$0.50 to \$1.00 per ton. The sawmill would have to install a storage bin, which probably would cost \$10,000 to \$20,000. Total cost for a sawmill producing 100 tons per day of sawdust and bark would be \$200 per day for disposal by landfill. Unknown factors that should be explored are the possibility of fire and contamination of ground or surface water.

68-0722

Ichikawa, K., C. G. Golueke, and W. J. Oswald. Biotreatment of Steffen House waste. *Journal of the American Society of Sugar Beet Technology*, 15(2):125-150, July 1968.

A biotreatment system for Steffen waste, produced in a beet sugar factory, incorporates the use of a mixed culture of yeast, algae, and bacteria grown on Steffen waste in lagoons. Of eleven strains of yeasts tested for their rate of growth in a

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pure culture, *Saccharomyces cerevisiae*, *S. william*, and *Mycotorula japonica* had the highest growth rate, reaching a concentration of 199 to 252 mg per liter in 44 hr. In a determination of the use of yeast as a primary treatment agent for Steffen waste, it was found that *M. japonica*, inoculated into sterile Steffen waste, reduced the COD of the waste by 23 percent in 48 hr, while increasing the concentration of the biomass to 700 mg per liter. Results showed the ratio of the volume of inoculum to waste should be at least 1 to 9, and that it is essential for most efficient treatment to use as inoculum, algal-bacterial cultures adapted to the environmental conditions under which the waste treatment will take place. Water enhances the rate and extent of COD and nitrogen removal (the latter as high as 72 percent) and results in a significant increase in the concentration of the biomass. A basic design was developed that calls for three steps: pretreatment in which air and carbon dioxide are bubbled through the waste to lower the pH and precipitate calcium; primary treatment in which wastes are passed through a two-pond series with a detention of 3 days in each; and secondary treatment in which the discharge from the primary pond series is passed into a large facultative pond.

68-0723

Industrial waste problem. Water and Waste Treatment Journal, 12(3):89, Sept.-Oct. 1968.

A decision was made by the British Minister of Housing and Local Government that farm effluents should be allowed into the sewer for treatment at sewage works subject to the payment of trade effluent charges permitted by legislation. It is expected that many authorities will see this decision in the context of industry in general and not farming in particular. The farming community will need to give some thought to the problem as it exists at the source, for if local authorities adopt the principle that farm wastes are twice as difficult to treat as normal domestic sewage, then the farmer will be faced with a sizeable financial problem, should the local authority expect to get the full cost of treatment.

68-0724

Bartels, R. The influence of differently treated communal sewage sludges on the quality and output of sandy soils (quantity and quality of the harvest). V. D. I. Zeitschrift, 110(2):64, Jan. 1968.

Whether sludge is applied to fields in the liquid state or is dried before use, costs are high, making this way of using sludge very questionable. To determine how a sandy soil of diluvial origin reacts to a single application of dried sludge, a field growing grass and one growing a root crop were fertilized with two differently treated sludges; both sludges were dried at 65 C for different periods of time, but one was mixed with a precipitating agent. The artificially dried sludge caused damage by excess fertilization. The field with the root crop showed an improvement in vegetation, especially with the sludge potassium fertilizer. The growth of grass improved by an average of 60 percent even in the post-fertilization year, and the thermally dried sludge produced an increase in output—after a second sowing—of 90 percent. Almost the same success was achieved with raw protein output. Since an increase in the pH value of the soil was found after two years, along with a rise in the humus content and a 14 percent jump

in absorbing capacity, the sludges can be considered suitable fertilizers. (Text in German)

68-0725

Isaac, P. C. G. Aerobic biological treatment of sewage. Journal of the Institute of Municipal Engineers, 95(2):58-65, Feb. 1968.

During the biological treatment of sewage about one-third of the BOD is destroyed by biochemical action and the remaining cell material and suspended solids are removed by settling. The biochemistry of aerobic sludge handling is considered, and two common methods utilizing this process are considered in detail. Percolating filter design and mediums are considered. Activated sludge design and the mechanism occurring in its use are described. Tapered- and step-aeration were developed to try to equalize the oxygen demand throughout the aeration unit. Contact stabilization is particularly suitable where most of the BOD is suspended or colloidal and can be adsorbed onto the surface of the microorganisms. It utilizes a short contact time and produces large volumes of sludge. Extended aeration is designed to operate at or near to the point of maximum microbial activity. It is generally utilized for small tributary populations and one of its purposes has been to reduce sludge handling problems. The Pasveer ditch provides for extended aeration and, in its simplest form, consists of an aeration ditch which can be of simple, earthen, construction. The sludge settles rapidly and provides a sparkling supernatant. It is useful for populations of approximately 1,000. In the future, it may be possible to utilize combined chemical and mechanical processes which will directly condition the surplus activated sludge for feeding to a filter. A great deal of attention should be paid to the possibility of doing away with primary settlement. If this could be accompanied by substantially increased BOD loading on the biological stage, the total weight of sludge for final disposal could be reduced.

68-0726

Isabell, R. D. Water and effluents in the paper industry. Surveyor and Municipal Engineer, 132(3,995):6-8, Dec. 28, 1968.

The process water intake, on the average, amounts to 20,000 gal per ton of paper or board produced. Reducing water intake at a mill to a practical minimum can result in benefits including lower water costs and a reduced volume of effluent for final disposal. If waste water is to be recycled, it must be reused for such ancillary processes as foam control, wire and felt cleaning, or suction box sealing water. Clarification to reduce the suspended solids content will generally be necessary. Savealls use sedimentation, flotation, or filtration processes to remove suspended solids. Removal of suspended matter and BOD reduction are the main requirements for effluent treatment, but other considerations such as pH, turbidity, COD, and the presence of toxic substances may arise. Sedimentation facilities vary from excavated lagoons to modern circular clarifiers. Chemical coagulation by flocculation can be used to obtain improved settling. Dewatering of sludge from settling tanks is carried out by the use of lagoons, drying beds, vacuum filters, filter presses, and continuous centrifuges. Attempts to find by-product uses for papermill sludges have been unsuccessful, and the economics of sludge incineration are unattractive.

68-0727

James, K. O. L. Brewery trade effluent dominates at Burton. *Surveyor and Municipal Engineering*, 132(397):42-44, July 1968.

A new 4.3.5 million Clay Mills sewage disposal works in England is now semi-operational and treating sewage with an unusual BOD of 600 to 800 ppm at a rate of 7 million gal per day. By careful planning and an additional expenditure of 6 1/2 percent over the costs of conventional plants, the life of expendable equipment has been increased from 2 to 5 years to several times this figure. Pilot-scale experiments have given data for the design of the works, and special emphasis has been given to construction materials which are resistant to hydrogen sulfide. The basic design is a two-stage biological treatment plant which adopts an alternating double filtration system with a rate of treatment of 75 gal. cu yd per day. The works are designed to deal with a dry weather flow of 7.5 million gal per day and can be easily extended to handle 10 million gal per day.

68-0728

Jenkins, D., and W. E. Garrison. Control of activated sludge by mean cell residence time. *Journal of the Water Pollution Control Federation*, 40(11):1,905-1,919, Nov. 1968.

A rational description of the activated sludge process is presented, and the way in which the effect of process variables can be predicted and process design and control can be improved by a knowledge of these principles, is demonstrated. The mean cell residence time is the most logical parameter on which to base the operation of an activated sludge plant. To use mean cell residence time for control, several measurements are required which necessitate reliable sampling of influent, mixed liquor, effluent, and return sludge. Preliminary results from experiments in progress since January 1967 are tabulated. The measurement of soluble COD in the effluent is an accurate indication of the efficiency of an activated sludge system. The measurement of suspended solids in the effluent reflects the efficiency of the gravity separation device (final sedimentation basins). A yield of 0.33 lb VSS per lb COD removed, and a decay coefficient of 0.04 per day were found from plant and pilot scale experiments for activated sludge treating domestic waste water.

68-0729

Joyce, F. Winter problem of waste disposal for Canadian cannery. *Effluent and Water Treatment Journal*, 8(6):293-294, June 1968.

Green Giant, a vegetable processing plant in Ontario, Canada, can operate only 9 or 10 months a year due to its inability to dispose of wastes during the winter. The plant needs a large quantity of water, some of which must be clean and uncontaminated for washing produce. The contaminated water is passed through a twig-and-leaf removal unit and through a hydrocyclone. Liquid is then passed through a pair of pressure filters linked to a pressure vessel which functions both as surge tank and backwash reservoir. Sterilization of all water used in the plant is by chlorination, with a minimum of 4 ppm residual. Thus, the plant is able to recirculate part of its water where it is required either as a conveyor or as a coolant, which reduces the cost of the municipal water

required. Waste streams from the separator, hydrocyclone, and filters are fed to a battery of six vibratory screens housed in a separate building. Solid wastes are separated and discharged in a semidry state to a hopper truck for disposal to fields. Clarified wastes from the vibratory screens are piped to a 300,000-gal holding pond. The liquids are sprayed over a 200-acre field. Recirculation saves the company 45 percent of the total water requirement and the waste load is reduced about 28 percent. During the winter the ground freezes and all spray irrigation has to stop. Plans are being made for a sewage collection and treatment system (an aerated lagoon) with further development of inplant recirculation.

68-0730

Judell, T. L. Methods of effluent treatment. *Food Manufacturing*, 43(4):27-29, Apr. 1968.

Principal methods of processing effluents from food factories are outlined. These methods are physical separation, biological treatment processes, land disposal and injection, and combined treatment with domestic sewage. The volume and characteristics of the wastes vary enormously among manufacturers of the same product, and also vary from day to day in the same plant. It is essential to study each individual case, rather than rely on published data, when designing a treatment plant.

68-0731

Juebermann, O., and G. Krause. The purification plant of the Erdoel Chemie GmbH and Farbenfabriken Bayer AG companies in Dormagen. *Chemie-Ingenieur-Technik*, 40(6):288-291, Mar. 1968.

The waste water purified in the plant at Dormagen, Germany, comes from the production of insecticides, plastic materials, synthetic fibers, etc. It has a varied pH value and a high salt content. A table lists all the substances contained in the waste water. The method and the equipment of the purification plant have been changed several times during the 4 years the plant has been in operation. Before the waste water is pumped to the prepurification tanks, it is neutralized. The prepurification process lasts about 3 hr, and the biological purification process lasts about 7.2 hr. The purification plant differs from most other plants of this size by the type of aeration used in the biological stage and by the method of dehydrating the sludge. The oxygen necessary for biological purification is brought in by ejectors which are quite similar in construction to water jet pumps. The nozzle of the ejector has a diameter of 8 mm at the narrowest point. Four ejectors are connected to a common water and air supply line, and are arranged in rows at the bottom of the purification tank. One tank has 208 ejectors or one ejector per cu m. Sieves protect the ejectors from clogging. The ejector heads are made of bronze, the nozzles of steel 4541, and they are corrosion resistant. The coating of the pipes made of ordinary steel has been heavily corroded. All have now been replaced by plastic pipes. The ejectors worked satisfactorily and the amount of oxygen was adequate. The sludge, which accumulates during the prepurification process, and the excess biological sludge are treated separately. The former is dehydrated in rotating vacuum filters by adding flocculants, the latter is dehydrated in centrifuges. The water

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separated by the centrifuge has a solid content of only 20 mg per liter. It is returned to the purification tanks. Capital costs are kept down with this method of sludge treatment and the results are satisfactory. (Text in German)

68-0732

Kamber, D. M., and J. E. Edinger. Conversion from primary treatment to extended aeration. *Public Works*, 99(4):110-112, Apr. 1968.

The original plant was designed on the basis of 54,000 gal per day. An extended aeration system was added to provide flexibility and to effectively treat wide variations in sewage flow and characteristics. The existing digester was used as a mixed-liquor aeration basin. This involved constructing a new secondary settling tank and converting the existing primary settling tank to a sludge storage tank. The individual components of the system are described in terms of the loadings and aims of the systems. At average daily design conditions of 75,000 gal per day, 360 mg per liter BOD, and 143 mg per liter total solids, the final effluent quality will be 43 mg per liter BOD and 21 mg per liter suspended solids. This is a BOD removal efficiency of 88 percent and a total solids reduction of 86 percent. Tabulations of the computed plant performance are given.

68-0733

Kambhu, K., and J. F. Andrews. An aerobic thermophilic process for the biological treatment of wastes—simulation studies. Presented at 41st Annual Water Pollution Control Federation Conference, Chicago, Sept. 23, 1968. Clemson, S. C., Clemson University. 37 p.

Simulation studies are presented to show that sufficient heat can be generated in the aerobic digestion of organic solids to make the process self-sustaining in the thermophilic range (45-65°C). The simulations are for a mixture of primary and activated sludge from a city of 10,000. The per capita contribution of total solids is assumed to be 0.2 lb per day, of which 70 percent is assumed to be volatile, and of the volatile solids, 70 percent is assumed to be biodegradable. Both dynamic and steady state models were prepared. Results show that the process should be self-sustaining, with respect to temperature, for the treatment of sewage sludge, either alone or mixed with garbage. Higher temperatures and increased volatile solids destruction may be obtained by: increasing oxygen transfer efficiency; using thickeners to increase the concentration of solids in the influent sludge; addition of ground garbage to the reactor; and insulation of the reactor. In operating the process, it is desirable to avoid the pumping of dilute sludges to the reactor, or the use of excessive aeration. Both of these practices can result in substantial decreases in reactor temperature and decreased destruction of volatile solids. The model should serve as a valuable framework for future modifications.

68-0734

Kaschke, W. Treatment of waste water in the metal working industry. *Wasser, Luft und Betrieb*, 12(10):622-625, Oct. 1968.

The purification of the many different waste waters from metalworking plants is discussed. The last section is devoted to the dehydration, incineration, and dumping of high water

content (96 to 99%) sludges which remain after waste water purification. These sludges are usually separated from the waste water in large settling tanks. For better purification and faster settling, flocculants are often used. Because the high water content of the sludge makes transportation difficult and expensive, sludge dehydrators are employed to reduce the volume to half of the original amount. Drying in beds or filtering reduces the water content to between 60 and 80 percent. Vacuum filters and filter presses achieve a solids content of 20 to 45 percent, but they are quite expensive. Traveling screen presses save space and achieve better results than drying the sludge in beds. The costs involved in the dumping of sludge are between 8 and 15 DM per cu m. About 55 percent of the costs can be saved by dehydrating sludge. Metal hydroxide sludges can cause considerable difficulties when dumped, so the geological conditions of the dumping site should be investigated. If no possibility for dumping exists, the sludge must be incinerated either by itself, or with refuse or sewage sludge. (Text in German)

68-0735

Kemmer, F. N. The treatment of strong industrial wastes. *Industrial Water Engineering*, 5(5):17-21, May 1968.

Strong industrial wastes are roughly classified as ion exchange regenerants, pickling or processing liquors, by-product streams, and cleaning solutions. The methods which are used by various industries for handling these strong wastes may be generally categorized as: fractionation, precipitation or crystallization, concentration, combustion, and direct disposal on or under the ground. The fractionation process is illustrated from examples taken from the textile and metallurgical industries. The food industries have used evaporation and drying processes, to produce concentrated products from strong wastes which would otherwise be high BOD nuisances. These reclaimed products are used as animal feed supplements or protein solids. The acceptance of incineration systems for industrial waste disposal is still in its infancy, and underground disposal is still a controversial subject. In direct land disposal, crops must be planted and irrigated in a fashion that avoids concentrating salts at the roots and on the foliage.

68-0736

Kempa, E. Processes of total elimination of sewage sludge. *Gaz, Woda i Technika Sanitarna*, 42(2):52-55, Feb. 1968.

The elimination of sewage sludge is one of the most important tasks in the technology of sewage purification. The sanitary aspects require treatment so that it is of no abuse to the surrounding environment. The paper surveys various natural and artificial methods of sewage sludge removal and indicates the structure of removal costs. It lists the advantages of thermal treatment as compared to biochemical methods, and gives special attention to the gasification of wastes. Before the actual thermal treatment takes place, the sludge is condensed, dewatered and dried. The final process of drying raises special economic considerations since it may consume the greatest amount of energy involved in the treatment of sludge. Essentially, gasification is the oldest method of thermal elimination. Technical aspects of this procedure were solved at the beginning of this century. The paper surveys the development of the gasification procedure and mentions the best known applications of its specific features. For some time, however, the gasification of sewage

ludge was dropped because of the rather complicated preliminary preparation of the sludge (dewatering, drying, briquetting, etc.), and because of the high amount of ash involved (exceeding mostly the level of 30%). The latest technical developments indicate that this problem has been overcome. To illustrate this, a description is given of a large-scale application in Essen, Germany. Of considerable interest is a plant which purifies water from the river Emscher at a rate of 13 cu m per second. (Text in Polish)

68-0737

Kempa, E. Processes of total elimination of sewage sludge. (II. Combustion of sewage sludge.) *Gaz, Woda i Technika Sanitarna*, 42(3):89-91, Mar. 1968.

The paper is a continuation of a survey of sewage sludge removal methods. It describes and evaluates several methods of incineration. Attention is given to the rotary furnaces of Herreshoff which have been in use in the chemical industry since 1885, and have been used for drying and incinerating sewage sludge since 1934. With these devices the moisture content of the introduced sludge may not exceed 60 percent. The Herreshoff furnaces have a number of advantages and they serve as a basis for the Ebingen method of municipal sewage and rubbish elimination. Although the moisture content of the treated sludge may not exceed 88.5 percent, this elastic method shows good energy balance and represents a big step forward. In the Raymond furnace, sludge is first dewatered on filters and then mixed with dried sludge in the ratio of 1:2; the moisture content of the remaining mixture is under 45 percent. The largest Raymond in Chicago handles sewage from 4,800,000 inhabitants. In the United States several plants of this type are capable of treating 1.35 to 500 tons of dry sludge daily. (Text in Polish)

68-0738

Kincannon, D. F., and A. F. Gaudy. Response of biological waste treatment systems to changes in salt concentrations. *Biotechnology and Bioengineering*, 10(4):483-496, July 1968.

The effect of sodium chloride on the yield of biological solids and on the ability of continuously cultured heterogeneous microbial populations to remove substrate was assessed. This was done by changing the salt concentration in a synthetic waste. When the salt concentration was increased to 30,000 mg per liter, the system could not maintain a high substrate removal efficiency. However, after an acclimation period, the system regained its former efficiency. After returning the feed to fresh water medium, it was indicated that the ability of the cells to withstand the salt concentration of 30,000 mg per liter was not passed on to progeny. Upon diluting the salt a significant rise in cell yield was noted as the salt level passed through the range 8,000 to 10,000 mg per liter. It was found that steady operation at a salt level of 8,000 mg per liter sustained the cell yield at a high level. Response to various salt loadings is shown in charts.

68-0739

King, F. M. W. Trunk sewer or local sewage works. *Surveyor and Municipal Engineer*, 131(3,950):34-36, Feb. 17, 1968.

The possibility of using a trunk sewerage plan for West Dorset, England, utilizing a long sea outfall for the disposal

of domestic sewage, is discussed. The large projected population increases for the areas of East and West Dorset made the trunk sewage scheme attractive, since the effluent from a conventional system must meet increasingly high standards. The present population in the suggested drainage area is 82,000; it is estimated to be 141,000 by 1981, and by 2001 the total population was estimated to be 264,650. Estimation of the total cost of the trunk scheme, including the submarine pipeline, pumping stations, main links, and interconnecting sewers would be £3,400,000 for the projected 1981 population and £4,800,000 for the 2001 population. The savings for the 2001 population, of trunk over conventional sewerage, would be on the order of £82,650. The full impact of the cost would have to be borne over a period of three years as this is the estimated time for building the trunk sewerage scheme. During the 1990's, the 'break-even' point would be reached.

68-0740

Kleinau, J. H. Prospects for sludge disposal by incineration. *Paper Trade Journal*, 152(45):79, Nov. 4, 1968.

The most promising approaches to the reuse of papermill and deinking mill sludges have revolved around recovery of the clay, which necessitates prior incineration. The high cost associated with the burning of sludges relates to the high water content of many sludges and their frequently low heating values. The use of organic filter aids is expected to eliminate some of these problems. The efficiency of a fluid bed reactor results in favorable conditions for the burning of sludges. A patented process is available to recover a fine white calcined kaolin clay from papermill sludges. Spray irrigation offers an effective solution to secondary treatment of deinking sludges.

68-0741

Koehler, F., and F. Moeller. Elimination of solid and liquid wastes which accumulate in new production processes. *Zeitschrift fuer die Gesamte Hygiene und Ihre Grenzgebiete*, 14(4):271-276, Apr. 1968.

To eliminate all accumulating industrial wastes properly, the amount and volume should be registered, the type of the waste and the best way to eliminate it should be determined, and the changes in the composition of the waste due to new production processes should be taken into account. Industrial wastes can be deposited in sanitary landfills, incinerated, or dumped into the ocean. All methods are briefly reviewed. The classification of the wastes by Kumpf, Maas, and Straub into combustible and compostable, only combustible, and neither combustible nor compostable is given. The distinction by Braun of industrial wastes which can be composted or incinerated like domestic wastes, and wastes which require special elimination methods is also given. Water insoluble, inorganic industrial wastes can be deposited. Water soluble wastes can also be dumped if the soil of the disposal site is impenetrable, if the ground water is not used, or if the disposal site is near a river so that the polluted ground water flows off into the surface water. In the German Democratic Republic, about 12 million tons per year of ash and slag accumulate, and this must be dumped. Incineration reduces the volume of wastes considerably, but it also leaves residues which must be dumped. The use of slag and fly ash in highway construction is still in the experimental stage. The

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composting of industrial wastes can be used only when the wastes do not contain excessive amounts of salt or substances which are toxic to microorganisms. The idea of dumping industrial wastes and sludges into the ocean has been discarded once again, because packing and transporting wastes into containers is too expensive. Acid sludges, sludges from waste water purification plants, and waste oils are best suited for incineration. Plastic material and synthetic fibers are incinerated in special furnaces. Wastes from the chemical and metallurgical industry are also mostly incinerated. (Text in German)

68-0742

Koehler, R. Waste water rich in organic substances from the food industry and its biological purification. *Wasser, Luft und Betrieb*, 12(6):343-348, June 1968.

The decomposition and elimination of organic substances in waste water depends on the growth of bacteria. Only a small portion is used to produce energy and the solved or colloidal organic substances are coagulated and adsorbed by activated sludge. Before diffusion through cell membranes, organic substances are liquefied by enzymes. Microorganisms require certain nutrients such as carbon, several minerals such as sulphur, potassium, etc., trace elements, and most important of all, nitrogen and phosphorus. No generally valid and precise amounts for the required nutrients can be given. Only values obtained by experience are known. A table lists the nutrient required for an effective decomposition of waste water from breweries, the potato, sugar, and dairy industries, from abattoirs, tanneries, and distilleries. Apart from certain nutrients, temperature is essential for good decomposition. The optimum temperature for aerobic waste water purification is around 20°C. Aerobic organisms thrive only at a pH value between 6 and 8.5. Biologic decomposition consists of five phases which are illustrated in diagrams. In the first phase, the bacteria absorb organic impurities; in the second phase, the bacteria multiply and simultaneously the BOD is greatly reduced; in the third phase, growth decreases due to the lack of nutrients, and in the fourth and fifth phases, the activated sludge flakes succumb to autolysis, thus becoming impurities. (Text in German)

68-0743

Koenitzer, G. H. Paper mill sludge dewatering. *TAPPI*, 51(12):53A-56A, Dec. 1968.

The vacuum filter, centrifuge, and press are generally considered. The vacuum filter has greater solids recovery than the other methods, but also has economic disadvantages. The centrifuge is the most versatile and requires a minimum of auxiliary equipment. A wide range of inlet consistencies can be handled by the centrifuge, and it produces drier cakes than a vacuum filter. The centrifuge additionally has the disadvantage of wear. The press produces the driest cake, and because of the slow operating speeds, 2 to 12 rpm, is more resistant to wear. It is a simple piece of equipment with few mechanical variables, but has the disadvantage of being applicable to only a limited number of sludge problems. Diagrams and photographs of the equipment, and the cakes obtained are given along with an analysis of a typical problem.

68-0744

Koehler, R. Small rotting plants for the treatment of municipal and industrial waste water sludges. *Wasser, Luft und Betrieb*, 12(1):21-24, Jan. 1968.

Studies made of municipalities with populations of 2,000 to 20,000 show that about 54.5 percent of all the annually accumulating waste water is not subjected to any cleaning at all, 29 percent undergoes a mechanical purification, and only 16.5 percent is mechanically and biologically treated in purification plants. These percentages indicate the great potential demand for the construction of purification plants by smaller and medium sized municipalities. This demand led to the development of prefabricated and even standardized sludge rotting plants, just as it led to the development of prefabricated purificant plants. Prefabricated rotting plants with rotting tanks of 175, 240, 320, and 420 cu m volume, and with either one or two stages, are available for communities with a population of 3,000 to 20,000. Graphs are given which should help in the selection of the right type of equipment. The prefabricated rotting plant consists of a rotting tower, a service tower with pump, and heating, tank, gas and personnel rooms. The service tower required a surface of 2.5 by 2.5 m, and together with the rotting tower, needs a flat concrete trough. This small prefabricated sludge rotting plant fulfills all the requirements which are expected from large plants. Thus it is possible to mix cold fresh sludge with warm decaying sludge so that activation and preheating is already achieved in the charging process. By preheating the fresh sludge, the condition of the methane bacteria is improved and the rotting process is intensified. After completing the rotting process, the sludge and the extracted water flow off separately. The gas arising in the rotting tower is collected at the top and reaches the gas room by its own pressure. The rotting tower, the service tower, the transport of the prefabricated parts, and the erection of the service tower are illustrated. (Text in German)

68-0745

Koppernack, F. Purification of highly varying waste water from the Merck pharmaceutical plant. *Chemie-Ingenieur-Technik*, 40(6):263-268, Mar. 1968.

The sewage plant of Merck, Inc., which is two years old, includes mechanical and biological purification stages, as well as a sludge incinerator. About 22,000 cu m of waste water are treated daily. The waste water varies greatly in its composition and quantity, since the company produces everything from pharmaceuticals to insecticides, reagents, and chemicals. In mechanical purification the waste water passes through a sand trap, a trash rack, and then into a venturi canal. The pH value is determined and adjusted if necessary by adding lime. The desired pH value (6, 5, 4, and 3) can be manually adjusted. Next, there is an aerated sand trap where fine particulates are retained and volatile components escape. In the following round tank with a volume of 1,600 cu m, the suspended particles settle to the bottom and are pumped to the dehydrator of the biological stage. From the mechanical stage the waste water goes into three great mixing tanks (total volume 42,000 cu m). Behind the third tank, the water is pumped to an elevated tank from which part of the water falls back down into the third mixing tank, picking up oxygen on its way. After the BOD is

regulated, the water is purified in three aero-accelerators. Each has a capacity of 1,100 cu m per hr. Then 930 cu m per hr of waste water are treated at the biological stage. Six compressors bring in the required air (all six together have a capacity of 390 cu m air per minute). The BOD averages 850 mg per liter. After 2 years of experience with the plant, it can be said that 95 percent of the impurities in the water are removed. The purification capacity of the biological stage is about 20 tons BOD per day. The excess activated sludge and the sludge from the settling tank are dehydrated, mixed with a flocculant and with ash, and again dehydrated. The dried filter goes to a 10-story furnace. One-third of the accumulated ash is reused in the process; the rest, about 10 tons per day, is dumped. The daily operating costs are 3,000 DM without amortization; the investment costs about 16 million DM and the purification costs per cu m waste water with amortization are 0.36 DM. (Text in German)

68-0746

Korejs, J., and I. Spicka. The operation of an activated sludge tank with extremely high activated sludge concentration. *Gas und Wasserfach, Wasser und Abwasser*, 109(34):930-936, Aug. 1968.

The behavior of activated sludge with an extremely high concentration of dry substance is discussed. So far it has been assumed that such a sludge does not settle down very well, and that it is difficult to separate the air bubbles from this sludge. Experiments were conducted on a mixture of domestic waste water with waste water from synthetic rubber production in four periods covering almost 3 years. Twice a week the concentration of the activated sludge and of the volatile suspended substances was determined. In the third and fourth period, the content of oxydizable material was determined. Moreover, the characteristic features of the domestic waste water during the first and second period were determined and are listed in a table; the same determination was performed with the waste water from the synthetic rubber production. The relationships between oxydizability and BOD are shown, and the decrease in fluctuations of the pollutants is illustrated. Results show that an activated sludge concentration of 20 to 25 g per liter can be achieved easily and with a high purification effect. The above-mentioned mixture of waste water was cleaned within an average aeration time (approximately 11 hr), with the BOD being less than 0.04 kg per day per kg volatile substances and activated sludge particles. The obtained sludge can be easily dried in drying beds without developing any odors. It was also found that the purification was only slightly reduced when the oxygen concentration in the activated sludge mixture was below 2.0 mg per liter. (Text in German)

68-0747

Kotze, J. P., P. G. Thiel, D. F. Toerien, W. H. J. Hattingh, and M. L. Siebert. A biological and chemical study of several anaerobic digesters. *Water Research*, 2(3):195-213, Mar. 1968.

Biological and chemical analyses were carried out on several digesters operated on laboratory-, pilot-, and full-scale. These digesters received a variety of substrates which included raw sewage sludge, industrial effluents (winery, glucose-starch,

and yeast wastes) and a synthetic substrate. Hexose monophosphate shunt enzymes could only be demonstrated in very active digesters receiving substrates high in carbohydrate material. The glycolytic pathway, glyoxylic acid, and citric acid cycles were found in all the anaerobic digesters. Enzyme activity tests revealed different stages of adaptation of a raw sewage digester adapted to a synthetic substrate. Digesters receiving different substrates showed characteristic enzyme activity patterns, but chemical analysis such as pH, alkalinity, and volatile fatty acid content did not demonstrate any obvious differences between these digesters.

68-0748

Krakauer, S., and G. R. Feeley. Clarifier forms and removes sludge hydraulically. *Water and Wastes Engineering*, 5(12):39-41, Dec. 1968.

Experimental investigations into the operation and efficiency of the Aquapulse dynamic clarifier, which forms and removes sludge hydraulically through pulsing jets of water rather than mechanically, are described. The efficiency of the pulsing hydraulic system, designed to clean the bottom of the clarifier, was tested using pulses of differing periods and intensities. It was found that pulses did not disturb the stability of the previously formed sludge blankets, and had a beneficial effect in priming and accelerating blanket formation. The system's advantages were judged to be: the ability to compensate for inflow variation without affecting effluent quality; reduction of maintenance by the elimination of mechanical sludge-collection systems; and superior chemical feeding and mixing. Commercial units up to 100,000 gal per day are presently offered.

68-0749

Krikau, F. G. Neutralization is key to acid-liquor waste disposal. *Chemical Engineering*, 75(25):124-126, Nov. 18, 1968.

The disposal of waste pickle liquor, which consists of ferrous chloride, water, and some residual hydrochloric acid, is accomplished by neutralization with calcium chloride to produce ferrous hydroxide and brine-water calcium chloride. The next step is recovery of iron oxide from the ferrous hydroxide sludge by oxidation. Tests have shown that this can be returned to the blast furnace. The calcium chloride solution is evaporated and reacted with sulfuric acid, which produces gypsum and hydrochloric acid to be recycled to the pickling operation. Use of neutralization was indicated because a deep well or regeneration process were too expensive or unfeasible. The capital costs of the neutralization process are lower than the other processes, and the utilization of the iron oxide and the recovery of hydrochloric acid provide reductions in the high operating costs.

68-0750

Kulakowski, A., and J. Kielinski. The method of sludge activation applied to postcellulose sewage purification. *Przegląd Papierniczy*, 24(1):16-19, Jan. 1968.

Aerobic sludge stabilization proves to be an effective means of improving the technology and economy of biological

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sewage purification. The principles and modifications of the contact stabilization method are discussed. The relationship between the stabilization time and the BOD reduction, for various contact periods, is of importance. In the case of extended chambers, the process of sewage purification by aerobic treatment is practically concluded at 1/3 to 1/2 of the chamber length. The stabilization of the activated sludge should therefore be undertaken separately. Bolotina's investigations have shown that the sludge index decreases by 20 to 30 percent, depending on the duration of the activation process and the amount of air provided. Weston and Rice state that by contact stabilization, a higher degree of removal of the impurity load is obtained in terms of BOD than when applying the conventional methods of sludge activation. Contact stabilization has been utilized in all purification plants in Moscow and in the United States. Consideration was also given to the application of sludge purification in cellulose and paper mills, especially in the United States. In Mobile, Alabama, the purification plant comprises chambers which process daily 94,700 cu m of sewage. The plant in Spring Grove, Pennsylvania, has a daily capacity of 75,600 cu m. In the U.S.S.R., a purification plant in Sviatigorsk has a daily capacity of 50 to 180 cu m in terms of the BOD. Another plant began operation in 1964 in Zydzacov. The largest purification plant in the world with the capacity of 280,000 cu m per day began operation in 1965 in Kotlas. Even in the initial period of the plant exploitation, the reduction of BOD amounted to 91 percent. (Text in Polish)

68-0751

Kumke, G. W., J. F. Hall, and R. W. Oeben. Conversion to activated sludge at Union Carbide's Institute Plant. *Journal of the Water Pollution Control Federation*, 40(8):1,408-1,422, Aug. 1968.

Through conversion of its aerated-stabilization process to a completely mixed activated-sludge system, Union Carbide's synthetic organic chemicals plant at Institute, West Virginia, has reduced the quantity of organic matter discharged about 70 percent. The conversion was carried out by installing additional surface entrainment aerators, by modifying the blades of the existing aerators, by adding two peripherally-fed secondary clarifiers, and by adding sludge recycle facilities. Basic studies of oxygen transfer, basin mixing, and clarification were conducted to optimize the system performance. Factors of most significance were aerator mixing capacity, clarifier flow patterns, and residual materials inhibiting the settleability of the sludge. A direct route involving land reclamation was selected for disposal of waste sludge. Future plans include modification of process equipment to improve oxygenation and contact within the aeration basins, and to remove those materials interfering with solids separation and mass transfer.

68-0752

Kuester-Sange, K., and H. Perlitz. The purification plant of Schering Ag. Bergkamen. *Chemie-Ingenieur-Technik*, 40(6):280-283, Mar. 1968.

When the chemical plant, Bergkamen AG, was taken over by the Schering Company, the production of synthetic gasoline ceased and the production of pharmaceuticals and industrial chemicals began. Since the old purification plant was no longer suitable, a new one had to be built. The construction of the plant presented difficulties because the site was on a

coal mine. Some details are given about the construction of the plant, the purification process and the necessary equipment. Before the waste water reaches the purification plant it is pre-cleaned. The accumulating waste water is then collected in a pipe and flows to a pump which raises it to a level of 7.5 m. Coarse solids are retained by a rake. A mixing tank of 1,250 cu m (40 m long, 12 m wide), that receives the waste water, is equipped with a sludge dredger and stirring mechanism. Depending on the pH, either lime or sulfuric acid is automatically added at the first neutralization stage. This coarse neutralization is followed by a fine neutralization. The sludge which accumulates settles. The biological stage is still in an experimental stage, but will operate according to the activated sludge method. The sludge which accumulates in the entire purification process is pumped into a tank with a volume of 525 cu m. A sludge dehydration plant is under construction. To dehydrate the sludge, lime milk will be added as a flocculant. In a vacuum filter, the water content of the sludge will then be reduced to 75 percent. An incinerator plant will be built later where the sludge, together with other waste material, will be burnt. About 9 million DM have already been invested in the construction of the plant. Nothing is yet known about operating costs. (Text in German)

68-0753

Kutera, J. Communication on activity of the Institute of Agricultural Utilization of Sewage Waters in Wroclaw. *Gospodarka Wodna*, 15(3):119-120, Mar. 1968.

Utilization of waste waters in agriculture is important in two respects for the national economy. First, sewage is an important irrigation and fertilization source, and second, its biological purification is accomplished without building expensive industrial purification stations. In recent years, the Institute has carried out research on the fertilizing and irrigating effects of municipal town waters. The main research tasks in 1967 and 1968 concerned agricultural utilization of sewage sediment, utilization of sewage from malt houses and breweries, determination of allowed degree of salinity of irrigation waters, and the effect of sewage irrigation on ground water pollution. It is necessary to investigate the possibility of purification of waste waters of other industries, mainly those producing nitrogen-containing compounds, and to determine the chemical and microbiological parameters of the quality of irrigation waters. (Text in Polish)

68-0754

Lamb, J. C. Digest of sanitary engineering research reports. *Public Works*, 99(5):140, May 1968.

The use of filter presses for dewatering raw sludges is being investigated by the Water Pollution Research Laboratory at Stevenage. Using raw primary sludge from a single treatment plant, and limiting chemical conditioning to the use of aluminum chlorohydrate, the factors studied were: dosage of chemical conditioner; intensity and period of mixing during conditioning; length of storage of the raw sludge and the aluminum chlorohydrate solution; hydraulic resistance of the filter cloth; and hydraulic resistance of the drainage surface of the press plate. It was found necessary to add increasing dosages of conditioner to compensate for long periods of storage. Stirring at a relatively high rate almost completely destroyed the conditioning effect produced with

chlorohydrate. Field studies indicate that 4 hr of mixing provided in the full-scale plant was excessive and intermittent stirring was employed. It was concluded that mixing chemical conditioner with the sludge and the degree of subsequent mixing are crucial.

68-0755

Laredo, D., and F. A. Bryant. Silt removal from combined sewers. *Water and Sewage Works*, 115(12):561-564, Dec. 1968.

Arrangements were made at the Fall River Sewage Treatment Plant in Massachusetts to disinfect and desilt combined storm sewage at all loadings up to the hydraulic limits of the plant. The desilting facilities, costing \$80,000 to \$90,000, consist of a storm desilting basin, which is illustrated. Dimensions and configurations are tabulated. Chlorination facilities include new feeding facilities designed to act in proportion to the rate of flow. The component loading and detention time of the plant is tabulated as is the particle size distribution of inorganic material. Grain size distribution is graphed. Now that pumping and separation facilities have been developed for removing the inorganic material from the organic sludge, the desilting facilities can replace the grit chamber in many plants where the high portions of inorganic solids entering the plant are smaller than the size which conventional silt chambers can remove.

68-0756

Ledbetter, J. O. The complete waste treatment facility. *Water and Sewage Works*, 115(R1968):R132-R138, Nov. 29, 1968.

Solid, liquid, and gaseous wastes from municipalities, small industries, and individuals should all be treated at one location—the complete waste treatment facility. Difficult to treat gaseous and liquid waste streams should not be mixed with other wastes before arriving at the treatment plant; however, a common sewer for gas and waste water streams might be economical. Industries discharging the waste streams should be charged on volume of waste and difficulty of treatment. Solid wastes should be routinely incinerated. Ashes resulting from combustion, together with mineral particulates from waste gas streams, could be stabilized and incorporated into products such as building and road paving materials. Water treatment plant sludge may be mixed with other solids and hardened for use by the addition of cement or by internal plasticizing. A complete waste treatment plant would combine the municipal power plant and incinerator. Domestic refuse has a heating value of some 4,500 Btu per lb, and the 7 million Btu per capita per year available from this alone is about 10 percent of the electrical generating requirements of the United States. The excess activated sludge can be burned. In the complete treatment facility, some wastes can be reclaimed and some will neutralize others.

68-0757

LeRiche, H. H. Metal contamination of soil in the Woburn Market-Garden experiment resulting from the application of sewage sludge. *Journal of Agricultural Science*, 71(2):205-207, Oct. 1968.

Regular use of organic manures to produce market-garden type soil from ordinary agricultural soil on light land was

tried in Woburn, England, using farmyard manure, sewage sludge, and composts of these with straw and farm wastes. Analysis of the soils and of plants raised on the soils are given and show large quantities of trace metals in the soil. In addition, abnormally large quantities were taken up by the plants, but crop yields were not affected. Evidently, foreign metals can be retained in the soil for several years. The danger of their accumulating, when manures containing metal-contaminated organic materials are applied repeatedly, is emphasized. Data from the analyses are given.

68-0758

Levin, P. Sludge handling and disposal. *Industrial Water Engineering*, 5(4):16-25, Apr. 1968.

This assessment of sludge handling and disposal covers the unit processes currently used to stabilize, concentrate, dewater, and incinerate sludges. The alternative approaches for ultimate sludge disposal are evaluated both from technical and economic standpoints. The major problem is the dewatering process which precedes ultimate disposal. Filtering and centrifuging are often utilized because space for sludge drying or lagoons is not available. Data indicate that in the future, the most economical method of sludge disposal will involve concentration, stabilization, or digestion, and then transportation of the residue to an ocean or land disposal site.

68-0759

Levine, S. Open hearth slag produces new aggregate blends. *Rock Products*, 71(5):122, 124-126, 128, Mar. 1968.

A 20-million-ton waste slag pile from open-hearth steel making provides feedstock for new aggregate types at Vulcan Materials Company's new blending facilities in the Birmingham, Alabama, area. The steel furnace slag is combined with blast furnace slag to utilize the density characteristics of each. The blending is done on a 50 percent open-hearth and 50 percent blast furnace basis, and is accomplished by dumping alternately one car of each type. The blended slag is loaded into railroad cars for shipment to the stocking area. The washing system has two 3,000 gal per minute pumps. Water reclaiming is accomplished via a series of settling ponds. Clean water is returned to the lake where the pumps are installed. Operating procedures are outlined for four different plants, and some of the equipment used, such as dewatering classifier, cone crusher, sizing screens, and dust arrester and dust scrubbers are discussed.

68-0760

Lewin, V. H. Sewage sludge disposal—back to the land? *Effluent and Water Treatment Journal*, 8(1):21-24, Jan. 1968.

Sea disposal of sludge is possible only for communities living reasonably close to the coast, and presents almost unanswerable problems concerning possible eventual pollution. Disposal of sewage on land in a well-designed operation offers the most promising, and cheapest, solution to this problem. The history of sludge disposal on land is considered, and techniques used for pretreatment of the sludge are outlined. The full experience of the City of Oxford in utilizing mechanical surface aeration, sludge digestion, vacuum filtration and the disposal of the sludge to farmers is

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described. Further research into methods which can maximize the beneficial aspects of sludge used as fertilizer is necessary.

68-0761

Lloyd, D. O. The treatment of trade and domestic wastes. *Institution of Public Health Engineers Journal*, 57(3):112-145, July 1968.

Methods used for the treatment of trade effluents combined with domestic sewage, with reference to experimental and full-scale sewage treatment works, are illustrated. Specific reference is made to biological and sludge treatment methods. The cases considered are: the treatment of waste from carpet manufacturing; general industry and sugar beet production, mixed with domestic sewage; the treatment of strong textile effluents in admixture with sewage; and the treatment of tannery and gelatine wastes in admixture with domestic sewage. When trade wastes are connected with domestic sewage treatment plants, the need to obtain detailed information about the nature, quantity, and fluctuation of the discharge is emphasized.

68-0762

Loehr, R. C. Anaerobic lagoons: considerations in design and application. *Transactions of the American Society of Agricultural Engineers*, 11(3):320-322, 330, May-June 1968.

The anaerobic lagoon is discussed as a biological system different from aerobic lagoons. Anaerobic lagoons can function as liquid- or solids-holding units when surge capacity is needed, and they can be useful for holding animal wastes prior to field spreading. Factors such as sunlight, large surface areas, and shallow depths to promote dissolved oxygen are detrimental to maintaining an anaerobic environment. Under optimum conditions, such as warm temperatures, anaerobic lagoons can be loaded at high rates and adequate solids decomposition will occur. However, the higher the solids loading, the greater the accumulation of nonbiodegradable solids, and the greater the frequency of solids removal. Conversion of the wastes into gas, discharge of the contents to subsequent treatment units, and seepage into the ground are the only ways by which waste material is removed from an anaerobic lagoon. At least one-fourth to one-third of the active solids should remain so that an optimum anaerobic environment can be maintained. The advantages of anaerobic lagoons lie with wastes that are highly concentrated. Disadvantages of anaerobic lagoons are: the effluent can pollute streams, the ground water is contaminated unless the lagoons are sealed, and odor problems result with high sulfur wastes or when the lagoon is out of balance.

68-0763

Long, S. K. Citric acid from citrus waste by fermentation. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. E-6)

A project was designed for utilizing both citrus canning plant waste waters and citrus molasses, providing a partial solution to the problem of waste disposal while increasing the studies showed that mass transfer is a rate controlling factor in a laminar film flow reactor. On the other hand, high rates

of mass transfer are obtained in a well-mixed reaction vessel consumption of molasses. A major feature of the process is to use selected canning plant waste waters of high BOD content (500-50,000 ppm) sugar concentration needed for the fermentation of citric acid. Reducing the BOD in the waste water-molasses medium, and producing citric acid in sufficient quantities would make this process economically attractive as a method of waste disposal. The evidence accumulated thus far indicates that citrus molasses is a suitable substrate for citric acid fermentation, provided certain modifications of the molasses are made.

68-0764

Lowder, L. R. Modifications improve treatment of plating room wastes. *Water and Sewage Works*, 115(12):581-586, Dec. 1968.

The present configuration and operation of Western Electric's industrial waste treatment plant at Omaha, Nebraska, is described and major changes that were made during the 9-year period of operation are pointed out. Four treatment processes take place in the plant: neutralization, cyanide destruction, chrome reduction, and solids removal. The sludge remaining from the treatment processes is concentrated to 11 percent solids and is pumped to a portable tank for transport to a landfill area. An alternate to this last step is available if the sludge is centrifuged before being hauled away. Other features of the plant include: a lime-handling and slurry-mixing system; a chlorine system; a sulfur dioxide system; water wells; a flocculant aid mixing and metering system; complete instrumentation and alarm devices; and four pressure filters which serve as a standby for the solids removal phase.

68-0765

MacNeal, J. A. Sludge thickening and disposal at Downingtown. *Paper Trade Journal*, 152(45):77, Nov. 4, 1968.

The effluent treatment system at Pennsylvania's Downingtown Paper Company's three multicylinder board machine mill is described. Sludge from the 115-ft-diameter primary clarifier is pumped at about 3 percent consistency to a Rice Barton water extractor. The fine fraction of the sludge and most of the water are discharged from the bottom of the unit, where they are combined with the excess activated sludge from the secondary clarifier and pumped to the thickening tank. Underflow from the thickener, equipped with a Dorr-Oliver scraper mechanism, is discharged by gravity at 3 percent solids to a chest from which it is pumped to lagoons. Thickener overflow is returned by gravity to the primary clarifier. Chlorination has reduced odors and aided in sludge thickening.

68-0766

Maier, W. J. Model study of colloid removal. *Journal of the Water Pollution Control Federation*, 40(3):478-491, Mar. 1968.

Two model reaction systems were used to simulate the overall process of removing dissolved organic matter from waste matter by biological activity: a well-mixed batch reactor, and a film-flow reactor. Results from process variable

(simulating activated sludge conditions) due to eddy current transport. As a result, mass transfer is generally not a limiting factor. Hydrolytic degradation of colloidal starch into small soluble carbohydrates proceeds rapidly, and does not appear to be rate-limiting in either type of reactor. Based on the colloidal starch results, film-flow reaction systems are mass transfer limited. Therefore, it should be possible to improve the efficiency of such reactors, e.g., trickling filters, by increasing mass transfer. This could be accomplished by improved design and/or agitation to provide mixing in the liquid film.

68-0767

Marshall, P. G., W. L. Dunkley, and E. Lowe. Fractionation and concentration of whey by reverse osmosis. *Food Technology*, 22(8):37-38, Aug. 1968.

Whey contains about half of the milk solids, most of the lactose, about one-fifth of the protein, and most of the vitamins and minerals of milk. About one-half of the 22 billion pounds of whey produced in the United States each year goes to waste. Of 590 cheese factories in Wisconsin, over 50 percent disposed of whey as waste or sewage, over 25 percent paid processors about 2 cents per cwt, 15 percent gave whey to farmers, 4 percent sold whey to farmers, and 4 percent processed their own whey. Reverse osmosis has been suggested as an economical process that would concentrate whey and remove at least part of the lactic acid and salts. A Wurstack assembly, essentially a plate-and-frame filter that provides for passage of a permeate through a cellulose-acetate membrane, was used for the concentration of cottage cheese whey. Representative data from five runs are summarized. Data indicated the feasibility of using the membrane-separation technique to concentrate whey and to remove most of the monovalent salts.

68-0768

McGhee, T. J. A method for approximation of the volatile acid concentrations in anaerobic digesters. *Water and Sewage Works*, 115(4):162-166, Apr. 1968.

The relationship between acid concentration and apparent alkalinity was examined to provide a method sufficiently accurate and rapid to insure use by treatment plant operators. One such successful method was to titrate the clarified sludge with an acid to determine the slope of the titration curve at pH values between 4 and 5. The slope of the curve was found to correlate well with the concentration of volatile acids, so that any decrease in the slope could be understood as an increase in the concentration of the volatile acids. The experimental apparatus and procedure are detailed. The method is suggested as a supplement to the chromatographic technique.

68-0769

McKinney, R. E., and W. J. O'Brien. Activated sludge—basic design concepts. *Journal of the Water Pollution Control Federation*, 40(11):1,843, Nov. 1968.

The history of the development of the activated sludge process is examined to provide a foundation for the discussion of basic design concepts of modern systems. Progress has occurred largely as a result of empirical testing. Complete-mixing activated sludge has definite advantages

over other modifications of the process. Many design concepts hold true for both conventional and complete mixing activated sludge processes. Screening, grit removal, and primary sedimentation are normal treatments for most wastes, although some specific wastes may not require all three, and economic parameters also enter into consideration of primary sedimentation. The primary variables considered in aeration tank design are: feed pattern, retention time, microbe concentration, type of aeration equipment, quantity of air, and tank configuration. Secondary sedimentation tanks remove the microbial solids from the liquid and permit rapid return of the sludge to the aeration tank. Since sludge increases continuously, it is necessary to remove it continuously. It is important that a positive method be used for measuring the volume removed, and this volume must be removed at a uniform rate. Excess activated sludge may be dewatered and disposed on land, incinerated, or vacuum filtered. At times, tertiary treatment of the effluent is required when other nutrients create pollution.

68-0770

McLean, N. Applications of the principles of gas cleaning equipment. *Public Cleansing*, 58(6):261-264, June 1968.

Reduction of dust at its source should be attempted by methods including dedusting from the screens, pulverizers, conveyors, etc. which are normally at ambient temperatures. Cleaning of the incinerator flue gases, which can be highly acidic and can reach temperatures in the range of 900 C to 1,000 C involves cooling the gas before industrial gas cleaning equipment can be used. Waste heat boilers, heat recovery, cooling by air infiltration, evaporative cooling by water sprays, and saturation by gas washers are commonly used. Various principles, such as efficiency, economics, and capacity limitations, should be considered before selection of the equipment. Final gas cleansing is said to be best accomplished by electro-precipitators which, while one of the most expensive methods in terms of initial capital cost, are the most effective and economical in terms of total operating costs for large plants.

68-0771

McLean, N. Gas cleaning equipment. *Public Cleansing*, 58(4):167-178, Apr. 1968.

The principles of inertial separators, impingement separators, electro-precipitators, and other general types of gas cleaning equipment installed in refuse disposal plants, are described. A description of the efficiencies to be expected from each type of separator and its operation are included. Settling chambers, mechanical collectors, cyclone collectors, high efficiency cellular collectors, scroll collectors, gas scrubbers, town scrubbers, Venturi scrubbers, fabric filters, gravel bed filters, and electro-precipitators are described and illustrated.

68-0772

McMahon, J. F. Solid wastes in the ceramic industry. In *Proceedings: First Mineral Waste Utilization Symposium*, Chicago, Mar. 27-28, 1968. U.S. Bureau of Mines, and Illinois Institute of Technology Research Institute. p.108-112.

The literature pertaining to the advantageous use of ceramics wastes is reviewed. Questionnaires sent to 22 knowledgeable

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and dependable persons in the industry furnished relevant information pertaining to solid ceramic wastes. A summary of the nature of the wastes and the manner in which these wastes were handled are given in tabular form. Most of the industries' waste is landfilled. Those companies that have mining operations reported that: timber is salvaged; brush is burned or hauled to landfill; earthy materials are placed in a spoil bank; slurry is drained and/or pumped into streams; dust is collected and deposited in a spoil bank; and screenings are collected and salvaged. The industry now utilizes most of its wastes in: grinding and polishing media, refractory products, agricultural purposes, filters, aggregates, and extenders, and as additions to its normal products. Various branches of the industry have found outlets for ware which would be classified as seconds.

68-0773

Meier, E. B., and W. E. Korbitz. Central pretreatment of Omaha packinghouse wastewaters. *Journal of the Water Pollution Control Federation*, 49(4):627-635, Apr. 1968.

Wastewaters from the Omaha livestock and meat-packing industry flow directly to the Missouri River through city sewers with essentially no treatment. The city and the industry joined in an effort to find an economically feasible solution which would permit efficient operation of the city's new wastewater treatment plant, and yet preserve the advantages of the traditional wastewater disposal methods used by the meat industry. Wastewater will be discharged into a new and separate system of collector sewers which will deliver the waste water to four gravity recovery basins. The effluent from the gravity separation basins will receive further treatment in four air-flotation recovery basins. Effluent from the air-flotation systems will be released into the existing city sewer system. Settled solids and skimmings from these units will be conveyed mechanically to storage facilities, and then on to the Carver-Greenfield processing plant where the raw solids and fats will be converted into saleable, water-free fats, and dry, sterile, protein-containing solids suitable for use in animal-feed formulations. Operating costs, financing, and estimated income from the sale of grease and solids are included.

68-0774

Method to dehydrate sludges which are difficult to dehydrate. *Das Papier*, 22(5):280, May 1968.

The Passavant-Werke in Michelbacher Huette, Germany, has applied for a patent of a method to dehydrate sludges which are difficult to dehydrate. The inventors are Oswald Busse and Hugo Klesper. (Text in German)

68-0775

Metro[®] Toronto installs novel sludge conditioning system. *Water & Pollution Control*, 106(1):25, Jan. 1968.

Metropolitan Toronto has recently installed a sludge conditioning system of novel design. In this system, the polyelectrolyte used for flocculation is Dow Chemical's SA 1188.1. Under the original system, approximately 25,000 lb of ferric chloride solution and 30,000 lb of lime were used daily. The new system uses an average of 4,000 lb of the polyelectrolyte per day. Capital cost was kept to a minimum

by utilizing equipment already present, except for a rotary gear to feed the polyelectrolyte to a centrifugal pump which is used as a mixer.

68-0776

Middlebrooks, E. J., E. D. Breland, F. J. Coogan, B. J. Shell, and J. H. Stovall. Combined wood storage and waste treatment for the paper industry. *TAPPI*, 51(7):93A-97A, July 1968.

A sprinkling system has been successfully used to overcome the disadvantages of the underwater storage of pulpwood. In addition to preserving the wood, the process acts as a large trickling filter that has reduced the BOD of waste water by more than 50 percent. When the effluent from the woodyard was settled for 1 hr, the total BOD removals ranged from 45.9 to 82.5 percent with an average of 70.1 percent. Effluent from the primary sedimentation basin is distributed over the wood by oscillating sprinkler heads. Pulpwood is stacked directly on the ground. The wood is continuously rotated, with 1/12 of the stored wood being removed from the storage area each month. At an estimated volume of 2 million cu ft for the woodpile, the average organic loading applied to the filter was 2.71 lb BOD per 100 cu ft a day. Tables show the BOD, COD, and suspended solids concentrations of the clarifier and woodyard effluents. Some increase in cost, due to a more elaborate spraying and collecting system, is necessary, but the savings are substantial when compared to the cost of a typical waste treatment installation. If a system could be developed to apply the raw waste directly to the woodpile, a much greater advantage would exist.

68-0777

Miksch, J., and K. Roennefahrt. Purification of the waste water from citric acid production in the factory Ladenburg of the company Joh. A. Benckiser GmbH. *Chemie-Ingenieur-Technik*, 40(6):268-271, Mar. 1968.

The chemical company, Joh. A. Benckiser, which produces citric acid from molasses, also produces solid waste in the form of mycelia of fungi, gypsum, fermentation waste water, and waste water from the cleaning process. The gypsum is dumped into sanitary landfills; the mycelia are carefully dried and used as fertilizer because of their high nitrogen content. The fermentation waste water is dehydrated and burned in an incinerator. The cleaning water, which has a relatively low solids content, is biologically purified. The impurities in the waste water include molasses residues, sugar, citric acid, salt, and disinfectant. Before the biological purification plant was built extensive experiments were conducted with a model aero-accelerator. All conditions necessary for an effective biological purification of waste water, using the activated sludge method were investigated, and data that was necessary for planning and estimating cost was collected. The experiments were made with four different types of waste water: cleaning water (A); the waste water from another production branch in which insulation material (polystyrol) is processed (B); a mixture of A and B (C); and a mixture of waste waters A and B with communal waste water (D). The results are listed in detail in a table. Waste water A, with a BOD of 2,400 mg per liter, left the aeroaccelerator with a BOD of 40 mg per liter, (decomposition 98.5%); waste water B, with a BOD of 49 mg per liter, left it with a BOD of 10 mg

per liter (decomposition 89%); waste waters C and D attained a reduction rate of 99 percent and 93 percent. Based on these experiments, an aerocelerator plant was built with a total capacity of 1,560 cu m per day at an organic impurity rate of 760 kg BOD per day. The waste water is collected in a 140 cu m tank where pressurized air mixes the water vigorously. From here, the water falls into the aeration room, is mixed with activated sludge, and the biological decomposition, which began in the collecting tank, is continued. The activated sludge is separated again, and the purified water flows off. The excess sludge is dehydrated. (Text in German)

68-0778

Millward, R. S., and P. B. Booth. Incorporating sludge combustion into sewage treatment plant. *Water and Sewage Works*, 115(RN1968):R169-R174, Nov. 29, 1968.

Sludge combustion, the reduction of waste sewage solids to sterile ash, is proving to be an economical answer to scarce land and costly solids handling problems. Dorr-Oliver's FS system is described in detail. Fluidized-bed combustion can reduce sludge as much as 99 percent, while virtually eliminating odor and other air pollutants. In a typical process, sludge is fed into a DorrClone degritting system where 95 percent of the 200 plus mesh inorganics are removed. Degritted sludge is then concentrated in a Den-sludge thickener, after which a Sulzer disintegrator grinds the sludge to 3/8-in. particle size. The thickened sludge is further dewatered by a MercoBowl centrifuge, and the dewatered sludge is screw fed or pumped into a fluidized sand bed reactor. The fluidized bed (the combustion zone at 1,400 F) has a heat capacity of 16,000 Btu per cu ft, which, in combination with extreme mixing, produces complete drying and combustion in a matter of seconds. One application of a separate heat recovery system uses waste gas heat to preheat incoming air for combustion to as much as 1,000 F. This particular application is feasible on FS systems which accomplish drying and burning in a single compartment.

68-0779

Mobile sludge dewatering plant. *Water and Waste Treatment Journal*, 11(12):546, Mar.-Apr. 1968.

The Lynx Disc Filter, a compact mobile dewatering plant, is capable of treating the sludge from a population of 6,000 in an 8-hr day on the basis of 0.15 lb solids per person per day. The key feature of the machine is the new method of filtration. The sludge is pumped via the coagulant mixer unit, into the semi-circular sludge bath, through which the disc rotates. As the disc rotates through the conditioned sludge, a vacuum is applied to the filter cloth so that sludge adheres to the cloth while the filtrate passes through the cloth for discharge. The filter cloth on the disc needs to be replaced only after 1,000 hr of continuous use.

68-0780

Moore, M. E., and J. J. Todd. Sludge production in the contact stabilization process. *Effluent and Water Treatment Journal*, 8(11):551-560, Nov. 1968.

The contact stabilization process is examined to provide information on the quantity of sludge produced by the

process. The plant and equipment used are described and illustrated. Tabulations include: capacity of zones of the contact stabilization plant; design loadings; and actual plant loadings. Graphs of results are included and show feed conditions relative to design capacity during test period; sludge production and factors affecting production; sludge density and loading; and effluent quality. It was shown that the process can handle short-term high daily BOD loads greater than allowed for with little effect on BOD reduction. The gross sludge production, including all solids lost with the effluent, was 0.39 lb dry solids per lb BOD applied at temperatures from 6 to 10 C. Sludge production was shown to be directly proportional to plant loading. The temperature fluctuations during the survey seemed to have little effect on the gross sludge production. The average BOD load in this survey was 47 percent higher than the design load, but this had no effect on the efficiency at high MLSS levels. Measured peak BOD loadings on occasion reached five times design load, again with no apparent effect on BOD reduction. This process, with separate contact and stabilization zones and operated at correct MLSS levels, is adaptable to considerable changes in BOD strength and gives consistently good filtered BOD.

68-0781

Moyer, H. E. The south Lake Tahoe water reclamation project. *Public Works*, 99(12):87-94, Dec. 1968.

Development of a project to collect, treat, and remove sewage from the shore area of Lake Tahoe involved construction and development of an advanced waste treatment plant which would be capable of producing an effluent of high quality. The plant consists of a 2 1/2 mgd activated sludge treatment plant, tertiary treatment utilizing multimedia filters, and adsorption on activated carbon beds. A six-hearth furnace which burns both the biological sludge and the high phosphate sludge, and facilities for reclaiming the lime that was used for phosphate removal, were added. A stripping tower was installed for removing ammonia nitrogen. Illustrations include: a diagram of the plant itself, a map showing the pipeline used to transport the effluent from the basin, and the pumps used in the pipeline. The system is unique in that it transports water sufficiently pure to be directly reused. The collection system is designed and maintained to prevent infiltration of ground water, due to the expensive treatment and disposal system.

68-0782

Muers, M. M. Wastes from the processing of milk and milk products. *Water Pollution Control*, 67(6):644-651, 1968.

The value of the dairy industry to the national economy, and the type of operation it performs, are described in order to explain the sources and nature of the discharges produced, and their contribution to the total effluent. Suggestions, based on the experience of waste-saving campaigns, are made about how the milk and water losses may be tracked down, measured, and reduced. Dairy effluents, although differing from sewage in having a higher BOD and higher ratio of carbon to nitrogen, are amenable to the normal methods of sewage treatment such as high-rate filtration, use of plastic filter media and modified activated-sludge processes. For direct discharge, the ocean disposal and spray irrigation methods are the cheapest, but most urban dairies discharge to

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a town sewer, with frequent problems resulting. The high cost of either treatment or discharge to the sewer is the most serious aspect of a dairy's effluent problem.

68-0783

Mueller, W. J. Water economy in the years 1966 and 1967. V. D. I. Zeitschrift, 110(14):603-605, May 1968.

Measures taken to keep the water in rivers and lakes clean are reviewed, and 44 references are given. Through experiments it was found that toxic substances from dumped wastes or from waste water were still toxic after they had remained in the ground for 50 days, despite the purifying effect of the top layers. Such substances are chromic acid, cyanide, picric acid, insecticide, mineral oils and mineral oil products, and tar and tar products. The increased use of insecticides leads not only to destruction of living organisms in the water, it carries a latent danger to man himself. As far as the purification of the waste water is concerned, the BOD of the purified waste water must be reduced still further to below 10 mg per liter. The biological purification of industrial waste water is highly important. A common treatment of industrial waste water and municipal waste water is economical. The most important sludge treatment method is still the rotting method. Before the treated sludge is used in agriculture, all worm eggs must be destroyed by heat or by storing it long enough. In the purification plant in Nordhorn, Germany, (the organic amount in the sludge here is only about 40%) the aerobic sludge stabilization method has been successfully introduced. (Text in German)

68-0784

Municipal abattoir opened at Slough. Surveyor and Municipal Engineer, 132(3985):21-32, Oct. 19, 1968.

A new abattoir, designed to meet the stringent demands of hygiene and animal welfare, was opened at Cippenham Lane, Slough. Finishes throughout the building and its equipment have been designed specifically to resist corrosion, to facilitate cleaning, and to maintain hygienic conditions. Steam and high pressure hoses are situated at convenient points within the building for cleaning purposes. A steam line is provided to force the blood from the underground pressure tank to a high-level storage tank for disposal, by gravity, to motorized tankers. If necessary, it can be discharged to the normal sewerage system. Other facilities include a vehicle washing area and a manure bay with provision for trailers.

68-0785

Myatt, A. A. Assessment and selection of methods of sludge treatment and disposal. Effluent and Water Treatment Journal, 8(10):504-511, Oct. 1968.

The assessment of any sewage treatment proposal must consider the final disposal of the sludge produced in the plant. This must be considered when choosing equipment since the types of sludge will differ. As individual circumstances vary too widely to recommend a specific process or treatment, each project must be considered individually, and then each project examined in terms of capital, operational and maintenance costs, and overhead. Certain processes are examined in light of capital costs and the results are graphed. Other more common methods for

treatment are listed, as are the processes necessary for final treatment and disposal.

68-0786

Neubauer, W. K. Waste alum sludge treatment. American Water Works Association Journal, 60(7):819-826, July 1968.

A study was conducted in 1966 to investigate the characteristics of the clarifier sludge from selected water treatment plants, and to evaluate several methods of treatment. The study included the examination of two water treatment plants which utilize alum as a chemical coagulant, use upflow units for clarification, and treat Lake Ontario water. Four methods of treatment were considered: vacuum filters, centrifuges, lagoons, and drying beds. The two water treatment plants selected were: Shoremont Plant, Monroe County Water Authority, Rochester, New York, with a nominal capacity of 32 million gal per day; and Wolcott Plant, Wolcott, New York, with a nominal capacity of 1 million gal per day. The total solids content of the sludge discharged from both plants averaged approximately 4,300 mg per liter. Although the wastes had a relatively low total solids content, there was a high ratio of suspended solids. The wastes were also relatively light in unit weight, had low BOD and high COD, and were not readily settleable to concentrations suitable for handling. Based upon the ultimate disposal of these wastes by landfill, it was determined that at least 20 percent of the material should be solid. Of the four treatment methods studied, lagooning and centrifuging did not provide acceptable solids concentration. Bench scale, sand drying-bed studies produced a total solids content greater than 20 percent in about 100 hr, with a loading rate of 0.8 lb per sq ft. A precoated vacuum filter could also produce 20 percent total solids concentration. The filtrates from these processes could be recirculated to the water treatment plant influent, if the discharge of these wastes to surface waters was objectionable.

68-0787

New high in pulp waste cleanup. Chemical Week, 103(8):77-78, Aug. 24, 1968.

A Georgia paper company has won a development and demonstration grant from the Department of the Interior to make sure delayed-action tannic and lignin compounds are removed from effluents, and that these effluents meet new color-removal standards. A treatment plant was designed for a waste flow of 10 million gal per day and a BOD loading of 14,000 lb per day. Calcined lime is slaked with condensate from an evaporator to form a calcium hydroxide slurry with about 15 percent solids. The slurry is mixed with process waste water, flows into the flocc mix tank, and then to a clarifier. The calcium hydroxide combines with color bodies of the waste and settles out together with fiber and other solids discharged by the mill. Sludge is discharged to two 20-acre sludge-holding ponds. Decolorized and clarified waste flows to stabilization ponds.

68-0788

New prescription asked for industry's pollution ills. Chemical Engineering, 75(5):100, Feb. 26, 1968.

New approaches to obtain solutions to combat pollution involving liquid-gas absorption, scrubbing, and solids recovery

are discussed. For solid particle recovery, a commercial system is described consisting of a quench-saturation unit and a cross-flow Tellerette-packed scrubber. Overall dust recovery was 98 percent, but 32 percent of the dust was less than 2 microns in diameter. A much simpler device collects solid particles in municipal incinerator effluents. This new experimental system consists of sets of ribbons moving around two drive cylinders which are located in the duct through which the effluent travels. Solids are captured by inelastic collision on the ribbons, and transported to a brush that removes them.

68-0789

Pflanz, P. The sedimentation of activated sludge in final settling tanks. *Water Research*, 2(1):80-86, Jan. 1968.

Large-scale tests were carried out with the object of ascertaining how long it takes to remove a given amount of suspended solids by secondary sedimentation. Various plants were tested along with the corresponding secondary basins. The sedimentation process was examined by making a profile of the solids in rectangular basins. In addition, some tests were carried out while the sludge was subject to agitation and dilution. It was shown that a direct relationship exists between the hydraulic load of the basin and the total amount of suspended solids in the mixed liquor. This relationship was investigated, and it was noted that the quality of the effluent deteriorates with an increase in the surface feed rate. Statistically, the results indicate that satisfactory surface feed rates (2.5-3.5 kg dissolved solids per sq m) can be obtained at normal temperatures (13-15°C) with a sludge volume index of 100. In addition, it is shown that the solids surface feed rate is defined to a considerable extent by the settling qualities of the activated sludge.

68-0790

New Shell plant disposes of BOD. *Modern Manufacturing*, 1(6):233, Nov. 1968.

Shell Chemical Company is building a \$4-million secondary treatment plant in Houston. It has a capacity of 6,500,000 gal per day of waste water and will cost \$800,000 to operate annually. The treatment uses a highly concentrated colony of bacteria to consume the BOD materials (hydrocarbons, alcohols, aromatic compounds, organic acids, starches, and sugars). A flocculating agent is also used. Wastes are discharged into a primary clarifier and then into a flotation chamber to remove suspended and settling solids, which are then used as landfill. The waste stream is channeled into a secondary clarifier, and into a thickener where water is removed. The resulting sludge is also used as landfill. A small portion of sludge is returned to an aeration basin to continue the cycle.

68-0791

A new sludge removal bridge to empty drying beds in a purification plant in Saarbruecken, West Germany. *Gas und Wasserfach, Wasser, Abwasser*, 109(46):1,312, Nov. 15, 1968.

The purification plant in Saarbruecken not only purifies waste water, but also treats the sludge which accumulates in the purification process. To remove the dry layers of sludge

from drying beds, the plant uses a new bridge with a blade attached to a center wheel which runs on rails over the beds, and scrapes off the dried sludge. The rails are 20.5 m apart. The bridge operates on the concrete sides of the drying beds. There is no need for the installation of expensive new rails. The sludge, loosened by the blade, is thrown into a bucket which in turn empties into a waiting truck to carry off the dried sludge. Two bucket loads fill one truck. The bridge, which is operated from a remote control stand, has been patented in several European countries. (Text in German)

68-0792

Niemitz, W. Characteristic sludge data. *Gas und Wasserfach, Wasser, Abwasser*, 109(12):299-305, Mar. 1968.

The grain size of sewage sludges, their dehydration in centrifuges, their specific filter resistances, and their improvement by adding flocculants to the sludge were investigated. Samples of four types of sludges were strained in sieves with various pore sizes. To simplify the evaluation, the various grain sizes were narrowed down to four groups: less than 0.3 mm, less than 0.032 mm, 1 to about 30 microns, and filtrate. A table lists the mean values of the grain sizes found in the four sludge samples. Maximum and minimum values are also given. The values indicate that there is a clear difference in grain size between fresh sludge and rotting sludge. Fresh sludge has a higher amount of large and very fine grain sizes, while rotting sludges range between 1 and 30 microns. Experiments in the centrifuge were conducted twice: once under very favorable conditions; and once with the duration shortened and the revolution per minute decreased. Surprisingly the results of these centrifuge experiments showed no dependence on the rotting stage of the sludge groups. The two different centrifuging methods, however, did produce results which differed from each other depending on the original solids contents. Correlation calculations showed that the best correlation exists between the original solids contents, and the longer centrifuging process at a high number of revolutions per minute. To determine the improvement in specific filter resistances by addition of flocculants (in this case ferric chloride), the optimum dose, using the Gentner formula, was determined for all sludge samples. Each was then treated with the calculated amount of ferric chloride, and the specific filter resistance was determined. For 80 percent of the tested sludge samples, the minimum filter resistance was achieved. The various types of sludges showed a vastly different dehydration behavior. No clear-cut theoretical interpretation of the results is possible, nor are they of any practical help (Text in German)

68-0793

Nishikawa, S., and M. Kuriyama. Nucleic acid as a component of mucilage in activated sludge. *Water Research*, 2(11):811-812, Nov. 1968.

Activated sludge consists of flocs which are composed of a gelatinous mucilage containing large numbers of microbial cells. High amounts of polymerized DNA and RNA have been found in the mucilage. These have been folded in the sludge floc and protected with metal ions. The procedure of the investigation is described. Some other findings are: mucilage containing polymerized nucleic acid is obtained without

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breaking down the living cells by an extracting EDTA solution; the nucleoprotein released by autolysis from the microbial cells accumulates and is prevented from enzymatic depolymerization.

68-0794

Non-volatile matter in waste waters. *Svensk-Papperstidning*, 71(20):753-754, Oct. 31, 1968.

A technique for determining the non-volatile matter in waste waters is detailed. It is intended for use on unfiltered samples of waste water having a dry matter content of less than 50 g per liter. SCAN testing methods have been issued and recommended by the Central Laboratories of the Pulp, Paper and Board Industries in Denmark, Finland, Norway, and Sweden.

68-0795

Noxious sewer lagoon odors required vinyl cover up job that had some bubble problems. *Engineering News-Record*, 181(15):43, Oct. 10, 1968.

When a Kalamazoo, Michigan paper company abandoned a process that had dumped waste with a high clay content into two sewage sludge lagoons, the organic content of the sewage grew past all expected levels and released noxious odors. The city installed vinyl covers at both lagoons for \$24,000 plus installation. Styrofoam vents with a suction pump in each vent pulled gases out and prevented bubbles from forming under the covers. The daily output of gas was about 20 percent methane and 80 percent carbon dioxide. Methods of eliminating the odors permanently are being considered such as the Zimmerman process, aerobic digestion, centrifuging, and vacuum filtration.

68-0796

Painter, H. A., R. S. Denton, and C. Quarmby. Removal of sugars by activated sludge. *Water Research*, 2(6):427-447, Aug. 1968.

The diurnal variation of the concentrations of sugars and volatile fatty acids in fresh and settled sewage at three sites was determined. Little loss of sugar occurred on settlement at two cities, where settlement was carried out aerobically. The sugars normally present in sewage were removed from solution by activated sludge at much the same rate as was added glucose. No simple relation was found between BOD loading and the ability of a sludge to remove sugars, but in general, the higher the sugar loading the greater the activity of the sludge. Activated sludge acquired very high, though variable, activity towards glucose on addition of this sugar to the sewage treated, but unlike pure cultures of two species of bacteria tested, the sludge lost this activity when fed with further amounts of the sugar alone in quick succession. At the point of complete, or near complete, removal of sugar from solution, variable proportions of the theoretical amounts of oxygen were taken up, namely 10 to 30 percent for glucose and 8 to 26 percent for sucrose. Biochemical removal of soluble substrates does not seem to be a limiting factor in the activated-sludge process, so that any limitation on the load applied would appear to involve flocculation or separation of sludge particles. Supporting data and references are furnished.

68-0797

Parker, C. D. Food cannery wastes treatment. *Food Technology in Australia*, 20(3):74-75, 77, 79, Feb. 1968.

A full-scale treatment method for assorted waste, comprising not only sewage, but also the wastes from a bacon factory, two milk processing plants, a butter factory, abattoirs, textile mill, and laundry, includes primary sedimentation, separate, heated sludge digestion, and filtration. Treatment of cannery wastes including that from apricot, peaches, and pear canning, and citrus fruits and tomato canning, require further facilities. Anaerobic and aerobic lagoons and oxidation ditches were chosen in which the cannery wastes are piped separately, and then mixed with the purified sewage effluent flow to supply deficient nutrients. The lagoon units are built with 4-to-5-ft water depth, they are rectangular in shape with concrete inlet and outlet channels, and have pipe connections through the banks to interconnect the series of lagoons. The oxidation ditch installation is a modification of the Pasveer ditch. The characteristics of the sewage and of the various cannery wastes are tabulated.

68-0798

Parker, C. D. Food cannery wastes treatment. *Food Technology in Australia*, 20(3):114-118, Mar. 1968.

Treatment facilities are described, incorporating the use of an oxidation ditch in the treatment of cannery wastes, the treatment of partially purified lagoon effluents by the oxidation ditch process, and the use of anaerobic lagoons to treat fruit cannery wastes at heavy BOD loadings without odor. A pre-existing sewage plant provided effluent to supply nitrogen, phosphate and a digested sludge seed, which was found necessary for wastes in small tanks simulating anaerobic lagoons. The full development of these facilities for the treatment of both citrus and tomato waste is described. Tabulations include treatment of waste from a plant in an anaerobic lagoon; treatment after anaerobic lagoon; Campbell Soup Co. waste treatment lagoon performance; Campbell Soup Co. waste treatment lagoon performance on citrus wastes; performance of anaerobic lagoons on Campbell's tomato wastes; and costs of the treatment facilities. These are described as efficient methods of treating these wastes to a degree of complete purification, at costs acceptable to the industry.

68-0799

Pearl, I. A. Waste product use helps paper industry control pollution. *Environmental Science & Technology*, 2(9):676-681, Sept. 1968.

Disposal of the spent sulfite liquor from the acid sulfite wood-pulping process is accomplished through chemical utilization. The spent liquor contains approximately 50 percent of the solids of the original wood, and is about 10 percent solids. The lignosulfonates found in the liquor are used for preparing oil-well drilling muds. Roadbinding operations utilize the crude spent liquor. The crude liquor is used also as a binder for animal feed pellets. The lignosulfonates are used as concrete additives, for water treatment, and for various uses based on the physical and chemical properties of these liquor-derived products. The liquor is treated to produce vanillin and ethanol, as well as the lignosulfonates. The production of *Torula* yeast by

fermentation with the spent liquor is an important use. Tall oil skimmings from the concentrated black liquors of the kraft mills became a source of oils to replace vegetable oils in non-food markets. Dimethyl sulfide and methyl mercaptan are also produced. Individual plants are cited which utilize the liquors and the processes used are outlined.

68-0800

Peschiera, L., and F. H. Freiherr. Disposal of titanium pigment process wastes. *Journal of the Water Pollution Control Federation*, 40(1):127-131, Jan. 1968.

Wastes generated during the production of titanium dioxide pigment consist of dilute sulfuric acid, soluble salts, and insoluble materials, principally silica and unrecovered titanium dioxide. One disposal method consists of rubber-lined shore storage facilities for collection, and a barge for the disposal of acidic liquids and slurries at sea. Waste treatment facilities are used for the neutralization of waste liquids by dolomitic lime to a 4.0 pH, and subsequently disposed at the Middlesex County Sewerage Authority's treatment plant.

68-0801

Petru, I. A. Combined treatment of cotton mill and dairy wastes with sewage. *Water and Waste Treatment Journal*, 11(12):532-533, Mar.-Apr. 1968.

A combination of municipal waste waters with the effluents from a cotton mill and dairy was given a two-stage activated sludge treatment which offers considerable possibilities of adequate purification efficiency. The waste had the following approximate proportions: municipal 1.078 mgd, and 4,540 lb per day BOD; cotton mills 0.565 mgd, and 2,770 lb per day BOD; dairy 0.529 mgd, and 1,040 lb per day BOD. Synthetic sewage was used in the operational experiments, and the phosphorus and nitrogen as well as detergent, sulfides, copper, and chromium content were determined. The experimental model was in operation for almost three months as a two-stage activated-sludge process with an 8 kg per cu m per day BOD primary stage, and an 0.8 kg per cu m per day BOD secondary stage. The mixture of waste waters had the following values before treatment: pH 8.8 to 9.6, COD (dichromate) 606 mg per liter, and COD (permanganate) 178 mg per liter. In the primary and secondary stages, respectively, the total reduction of these values was: BOD, 70 percent, COD (dichromate), 60 percent, and COD (permanganate), 75 percent.

68-0802

Pfeffer, J. T. Increased loadings on digesters with recycle of digested solids. *Journal of the Water Pollution Control Federation*, 40(11):1920-1933, Nov. 1968.

Recycling of digested solids from the secondary digester back to the primary digester offers a means of increasing the loading rates, while maintaining the solids retention time necessary for adequate solids stabilization. The increase in retention time associated with recycling increases gas production and decreases the production of volatile solids. The prime factors controlling recycling are the concentration of the solids in the recycled sludge, and the ratio of desired solids retention time to the liquid retention time in the

primary digester. An equation is developed for the parameters affecting the rate of recycling necessary to obtain the desired solids retention time, and examples are used to illustrate the principles involved.

68-0803

Phillips, W. Crewe sewage disposal works. *Consulting Engineer*, 32(11):80, 82, Nov. 1968.

A new disposal works is being completed near the Borough of Crewe, on 34 acres of farm land. The layout is based on an ultimate population of 80,000 persons-the corresponding dry weather flow, after including an appropriate allowance for trade wastes, being approximately 5.7 million gal per day. It has been calculated that the suspended solids within the trade wastes might equal the domestic sewage of some 30,750 persons. Primary sludge and surplus activated sludge are discharged into any of three primary sludge digestion tanks, which are equipped with floating roofs, sludge heating, and circulating equipment. Gas from these tanks will be collected into a 12,000-cu-ft holder and utilized for firing the boilers in the sludge heater house. Sludge is then passed to the cold secondary digestion tanks, before being discharged to the longitudinal distribution channel of the sludge drying beds. Dried sludge is delivered either to wagons or to a portion of the sludge storage area. Part of the surplus excavated material has been utilized to form a flood bank alongside the River Weaver or deposited on a farm.

68-0804

Pine bark for purifying the water. *Wasser, Luft und Betrieb*, 12(10):644, Oct. 1968.

Ordinary bark from pine trees proved to be an excellent and inexpensive material for absorbing water-polluting oil refuse, according to experiments conducted in Sweden. The bark was pulverized or shredded and put into a nylon hose. The waste oil was rapidly absorbed. The oil-saturated bark provides an excellent fuel. After about 4 years spent on refining this absorption method, pulverized bark and nylon hose are now industrially produced in large amounts. A new factory which specializes in this will begin operation shortly. It will produce about 100 sacks of pulverized bark each weighing 60 kg and about 1,000 m of nylon hose daily. The bark absorbs various types of oil and similar products, not only heavy oil but also gasoline, etc. Two liters of pulverized bark absorb 1 liter liquid. The bark is then incinerated. (Text in German)

68-0805

Plastic pipe used for sludge disposal at Huber foundry. *Air Engineering*, 10(4):28, 30, Apr. 1968.

More than 4,000 ft of plastic pipe ranging from 6 in. to 16 in. in diameter convey nearly 8 tons per hr of sludge away from collectors in the foundry. Sludge flows by gravity, as a less than 1 percent slurry can be kept moving by booster water jets at all sharp bends and junctions. Centrifugally-cast, fiberglass, reinforced, plastic pipe, having a high resistance to abrasive wear and chemical action, was chosen rather than sluice trenches to carry out the complete environmental control concept used at the plant. Thirty-three wet-type dust

fermentation with the spent liquor is an important use. Tall oil skimmings from the concentrated black liquors of the kraft mills became a source of oils to replace vegetable oils in non-food markets. Dimethyl sulfide and methyl mercaptan are also produced. Individual plants are cited which utilize the liquors and the processes used are outlined.

68-0800

Peschiera, L., and F. H. Freiherr. Disposal of titanium pigment process wastes. *Journal of the Water Pollution Control Federation*, 40(1):127-131, Jan. 1968.

Wastes generated during the production of titanium dioxide pigment consist of dilute sulfuric acid, soluble salts, and insoluble materials, principally silica and unrecovered titanium dioxide. One disposal method consists of rubber-lined shore storage facilities for collection, and a barge for the disposal of acidic liquids and slurries at sea. Waste treatment facilities are used for the neutralization of waste liquids by dolomitic lime to a 4.0 pH, and subsequently disposed at the Middlesex County Sewerage Authority's treatment plant.

68-0801

Petru, I. A. Combined treatment of cotton mill and dairy wastes with sewage. *Water and Waste Treatment Journal*, 11(12):532-533, Mar.-Apr. 1968.

A combination of municipal waste waters with the effluents from a cotton mill and dairy was given a two-stage activated sludge treatment which offers considerable possibilities of adequate purification efficiency. The waste had the following approximate proportions: municipal 1.078 mgd, and 4,540 lb per day BOD; cotton mills 0.565 mgd, and 2,770 lb per day BOD; dairy 0.529 mgd, and 1,040 lb per day BOD. Synthetic sewage was used in the operational experiments, and the phosphorus and nitrogen as well as detergent, sulfides, copper, and chromium content were determined. The experimental model was in operation for almost three months as a two-stage activated-sludge process with an 8 kg per cu m per day BOD primary stage, and an 0.8 kg per cu m per day BOD secondary stage. The mixture of waste waters had the following values before treatment: pH 8.8 to 9.6, COD (dichromate) 606 mg per liter, and COD (permanganate) 178 mg per liter. In the primary and secondary stages, respectively, the total reduction of these values was: BOD, 70 percent, COD (dichromate), 60 percent, and COD (permanganate), 75 percent.

68-0802

Pfeffer, J. T. Increased loadings on digesters with recycle of digested solids. *Journal of the Water Pollution Control Federation*, 40(11):1920-1933, Nov. 1968.

Recycling of digested solids from the secondary digester back to the primary digester offers a means of increasing the loading rates, while maintaining the solids retention time necessary for adequate solids stabilization. The increase in retention time associated with recycling increases gas production and decreases the production of volatile solids. The prime factors controlling recycling are the concentration of the solids in the recycled sludge, and the ratio of desired solids retention time to the liquid retention time in the

primary digester. An equation is developed for the parameters affecting the rate of recycling necessary to obtain the desired solids retention time, and examples are used to illustrate the principles involved.

68-0803

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Industrial Wastes

collectors, rated at 30,000 cfm, located throughout the foundry, collect dust to be carried through the pipeline to the central disposal unit. Water, reclaimed from the sludges is recirculated, after filtering, through the pipeline network at 4,000 gpm.

68-0806

Ploos van Amstel, J. J. A. Wet oxidation of sewage sludge. *Chemie-Ingenieur-Technik*, 40(1/2):83, Jan. 1968.

Wet oxidation is a new method to eliminate sewage sludge in which organic substances are oxidized in the liquid state in the presence of air. The process takes place at 35 to 125 atm and at a temperature of 200 to 300 C. The Technical University of Eindhoven, Germany, has made a study to determine whether the conversion of wet oxidation is determined by the rate of diffusion or by the chemical reaction speed. In a bubble column, the oxidation of sludge (4% glucose solution) was observed at 220 C and 50 atm by means of oxygen partial pressure; the state of the mixture in the reactor, the size of the gas bubbles, and the duration of the gas and liquid phase in the reactor remained constant. The conversion speed is determined only by the diffusion of the oxygen in the solution, not by the oxygen partial pressure. The conversion thus is contact surface dependent, and it takes place quite rapidly. The phenomena can be described by a model of non-stationary physical adsorption of oxygen, succeeded by an infinitely rapid oxidation of non-diffusing material. Because of this finding, wet oxidation reactors can be designed three to four times smaller than before. The degree of oxidation of the dissolved organic substance in the experiment was said to be 90 percent. The importance of this method lies not in the complete elimination of organic substances in sludges, but in the fact that the incineration of dissolved or colloidal substances changes characteristics important to the further treatment of sludges, e.g. dehydration ability. (Text in German)

68-0807

Pohl, F. Purification plant for waste water. *Das Papier*, 22(2):L 20, Feb. 1968.

A. Kraft and H. Sonthheimer of Metallgesellschaft AG, Germany, obtained German Patent No. 1,200,219 on Mar. 9, 1967 (applied for on Feb. 6, 1962) for a purification plant for waste water which contains easily deposited solids. The plant consists of at least one reaction zone, one purification stage, and one circulation device. The high-pressure component of the circulation device acts as a shovel. It is adjustable in height and is attached to an opening of a vertical, cylindrical suction pipe which reaches close to the bottom. The suction pipe is rigidly connected with the circulation device, and rotates. (Text in German)

68-0808

Pollution control project for metal plating plants. *Water and Waste Treatment Journal*, 12(3):91, Sept.-Oct. 1968.

The Federal Water Pollution Control Administration of the Department of the Interior has made a grant to Beaton & Corbin Manufacturing Company of 70 percent of the total cost of a research project designed to treat wastes from metal plating plants. The pilot program, assisted by the National

Pollution Control Foundation, will serve as a model for 3,000 metal plating factories in the United States. Waste products which are to undergo treatment are nickel, chromium, copper plus cyanide solutions, and other spent acids and alkalis. The plant's rinse waters will be treated in a new 2-step system of sludge beds, and by several new reservoirs and recirculating systems within the plant. For treating the wastes, 11,300 gal of neutralizing chemicals costing \$3,000 per year will be required.

68-0809

Pomeroy, R. D. Design of sludge digestion tanks. *Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers*, 94(SA5):769-777, Oct. 1968.

New ideas in the design of sludge digestion tanks are presented. These new methods and improvements include: flat-bottom digesters with multiple sludge withdrawal pipes; open-ended pipes at the bottom of the digester for injection of compressed gas for digester mixing; 3 ft sq openings flush with the bottom of the tank to facilitate cleaning operations; sampling pipes of at least 3-in. diameter with discharges designed to avoid splashing; a membrane cover used in a windy location; large sized gas piping; and gas disposal in a small trickling filter plant by blowing it through a filter.

68-0810

Popel, F. Water quality and waste disposal problems in West Bengal, the Orient and Malta. *Gas und Wasserefach. Wasser, Abwasser*, 109(26):695-703, June 1968.

Problems of the preparation of drinking water, the purification of waste water as well as sludge, and sludge and waste disposal in West Bengal, the Orient, and Malta are discussed. The sludge which accumulates in waste water purification plants can be stabilized either by aerobic or anaerobic decomposition. In warm climates, the anaerobic decomposition can be performed almost without any heating of the sludge, so that less costs are involved than with the aerobic decomposition which requires much energy for the aeration of the sludge. The stabilized sludge can be dried in beds. The sludge dries so fast that the flies don't have time to develop their larvae. In areas low in precipitation, the sludge is distributed in thin layers. After 4 to 6 days another thin layer of sludge is applied on top of the pre-dried first layer. This is repeated as frequently as possible. The sludge can then be used as fertilizer. In Malta, investigations approved by the United Nations are presently being conducted to find the most economic method of disposal of the accumulating wastes. The waste collection method in these developing countries is rather primitive. Pictures taken in Calcutta and Jordan illustrate this. The value of the wastes for the promotion of plant growth is demonstrated by the tasty, lush cauliflower which flourishes on a waste disposal site in Calcutta. These waste fertilizers are needed for the re-cultivation of the desert in Egypt, Jordan, and India. (Text in German)

68-0811

Porteous Process unit readied for startup. *Environmental Science & Technology*, 2(12):1068, Dec. 1968.

The completion of construction of facilities for the steam treatment of sewage sludge at the Colorado Springs,

Colorado, municipal treatment plant, will mark the U.S. debut of the Porteous process. The process is a means for treating primary or secondary sewage sludge with steam to stabilize it and facilitate dewatering. The advantages of the process are that it is a compact, continuous operation, requires no sludge conditioning chemicals, has low operating costs, is adaptable to new or existing plants, and can be expanded easily to handle increases in capacity of the basic treatment plant. Operating costs for the facility, which has a capacity for handling 4,500 gal per hr at 5.6 percent dry solids equivalent, are expected to be about \$1.80 per ton of dry solids, an annual saving of \$130,000 to \$190,000 over the costs of previously used methods. The process can also treat wastes from food processing, pulp and papermills, textile plants, and agricultural and industrial chemical plants. Based on past studies of the Porteous process, vacuum filter cakes with as little as 55 percent moisture can be obtained, and 35 percent moisture can be achieved with filter presses.

68-0812

Precipitator cleans furnace metal smoke with 99.2 percent efficiency. *Waste Trade Journal*, 64(38):6, Sept. 28, 1968.

Quantities of flue dust removed by an electrostatic precipitator at the Charles P. Hull Company plant, North Arlington, New Jersey, are sold at an excellent price to smelters. Two A-size Precipitair modules, with three fans capable of moving 5,000 cu ft per minute, remove tin, zinc, and lead oxides from the smoke with an efficiency of 99.2 percent.

68-0813

Priestley, J. L. Treatment of effluents from food processes. *Food Manufacture*, 43(4):30-32, Apr. 1968.

Ways of dealing with effluents from particular sections of the food industry are described for: dairies, slaughterhouses, poultry processing plants, bakeries, fruit canneries, vegetable processing units, potato products plants, and yeast manufacturers. Fortunately, most food processing effluents are easily purified by well established processes. These generally involve the removal of solid matter by screening, settlement, filtration or centrifuging of the effluent, followed by destruction of dissolved and colloidal organic matter by biological oxidation. Chemical methods of treatment, apart from neutralization of acidity and addition of biological nutrient salts, have little application.

68-0814

A problem-solver for water pollution control. *Modern Castings*, 54(5):176, Nov. 1968.

A new foundry was constructed in Creston, Iowa, including treatment facilities for the chromate waste from the metal treating systems and fluorescent penetrant oils from inspection procedures. Waste enters a clarifier tank where caustic soda and ferric sulfate are added to precipitate fluorescent penetrant oil out of the water. Precipitated sludge settles to the bottom of the tank and is periodically removed for disposal in a sludge field, where it is used as landfill. Wastes from chromic acid operations are pumped first to a holding tank for later release to the waste treatment system. Basic conversion from hexavalent to trivalent chrome is accomplished by feeding sodium bisulfite to the solution in a

reaction tank. The treated solution overflows into the second side of the tank where caustic soda is added to raise the pH level, and the waste is then ready for discharge to the sewer.

68-0815

Proceedings; American Chemical Society 156th National Meeting, Organic Residue Removal from Waste Water, Atlantic City, Sept. 8-13, 1968. Washington, American Chemical Society, Division of Water, Air and Waste Chemistry. 92 p.

Preprints of papers presented at the meeting of the Division of Water, Air, and Waste Chemistry of the American Chemical Society were divided into the following groups: a symposium on organic residue removal from waste water; general papers on air; general papers on water; and a symposium on biochemical target systems of air pollutants. The topics covered in the symposium on organic residue removal included: suspended solids removal from waste water; adsorption of waste water organics of activated carbon and the reactivation of the carbon; organic removal by osmosis; and organic residue removal by oxidation with ozone and chlorine.

68-0816

Processing waste meat products. *Food Processing and Marketing*, 37(444):345-346, Sept. 1968.

A full scale plant has been designed to treat slaughterhouse waste and condemned meat for the production of both purified fat and high grade meal for animal feed. The process, known as Centrimeal, is divided into three stages: heating and sterilization, separation, and drying. A super-dry melter with heated shell and agitator sterilizes the raw material and evaporates part of the water contained. The slurry is passed through a strainer, and oversize material is diverted through a mincer after which the total slurry is fed to a decanter and two products (raw meal and a liquid containing fat, water, and fines) are discharged. Finally the fines and the raw meal are reduced in a continuous drum type dryer to about 10 percent moisture. Advantages claimed for the plant include: lighter colored fat, enriched protein content of the meal of which 90 percent is digestible, low labor cost only requiring two men for supervision, and low processing time.

68-0817

Proudfit, D. P. Selection of disposal methods for water treatment plant wastes. *Journal of the American Water Works Association*, 60(6):674-680, June 1968.

Several case histories relating to wastewater disposal problems together with their proposed solutions are discussed. A plan was devised for St. Paul and Minneapolis to alleviate the problems of waste disposal, air pollution, and waste of water, and to provide a new source of carbon dioxide. Basically, the plan includes a lime-recalcining plant and washwater recovery facilities to be constructed as an integrated unit. The lime-recalcining plant will accept the wet lime sludge from the sedimentation basins, and by means of a high-temperature (1,600 F) reactor, convert the calcium carbonate in the sludge to calcium oxide, which will be reused in the water-softening process. For each unit of calcium oxide introduced for softening, it is expected that

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1.1 to 1.2 units will be reclaimed in the closed-loop process. In pretreatment of the wet lime sludge before it is burned in the reactor, at least 60 percent of the magnesium hydroxide will be removed by recarbonation and centrifugal classification. The present production of 2,700 lb of dry solids per million gal of water treated will be reduced by at least 83 percent, or to 460 lb per million gal. The solids will be pumped to sludge lagoons, but the existing storage space will last six times longer. The plan also contemplates eventual disposal of part or all of the reduced solids volume by hauling it to a waste disposal area after natural drying has reduced the water content to a level suitable for handling. The hauling of solids is economically feasible when considered as a part of the overall waste disposal program.

68-0818

Pulp and paper industry finds pollution control costly. *Water & Pollution Control*, 106(3):43, Mar. 1968.

A survey by the Canadian Pulp and Paper Association indicates that from 1960 to 1966, \$64 million was spent to control water pollution. In Ontario, 42 mills have spent a total of \$39.9 million in the last 8 years to cut solids discharge, with a resulting 63.9 percent reduction. The 62 mills surveyed in Quebec spent \$19 million in the 1960-1967 period for a total 15.5 percent reduction. In Quebec, suspended solids, the most immediate problem, were reduced by 37.7 percent. For the whole of eastern Canada, total solids discharge has been reduced by 906,627 tons, or 38.8 percent. A great proportion of pollution control spending has gone toward building control equipment into new plants. This costs on the average one-quarter to one-third as much as establishing control in existing mills. Most companies have concentrated on reducing discharge of suspended solids; chemical discharge is a much less serious problem. It is estimated that it costs on the average \$418,300 per year over 7 years to reduce suspended solids by 42 percent or, roughly 6 percent per year.

68-0819

Research program 'Foam Slag Made Of Melting Slag'. *Brennstoff-Waerme-Kraft*, 20(5):210-211, May 1968.

The Battelle Institute, Frankfurt am Main, West Germany, discussed with representatives of power plants and of construction material plants the production of foam slag or slag pumice from molten slag. The slag which remains from power plants had the disadvantage that its composition, viscosity, temperature, and amount change constantly. Thus any treatment for further use becomes very difficult. In many cases, however, corrections can be made so that the amount of molten slag as well as the composition remain somewhat stationary. When this is achieved, gas forming additives are mixed into the molten slag and, in pressure stages, it is brought to effervesce. To use coal for the production of effervescent slag, it is expedient to melt it under reducing conditions and then oxidize it. At the same time, the gas forming material is added. Water vapor is used in this case. The reaction must take place under increased pressure. The material starts to effervesce when the pressure is released. It is important that the viscosity of the slag is influenced (by changing the oxidation stage of the iron) in such a way that the slag foam does not collapse. (Text in German)

68-0820

Reverse osmosis may be the answer to whey disposal. *Environmental Science & Technology*, 2(7):490, July 1968.

Whey, a byproduct of the manufacture of cheese, has no great commercial value and creates a large BOD load when dumped into water systems. However, whey may be disposed of by the process of reverse osmosis. Fourteen billion pounds of whey (two-thirds of the annual production) are discarded annually. Many states prohibit its being dumped into waterways. The reverse osmosis process is especially suited to small volume cheese plants producing about 15,000 lbs per yr. The process removes from 75 to 80 percent of the water from whey, but the clogging of membranes with precipitated solids remains a problem. The process could be economically feasible in 1 to 3 years. At present, whey is recovered in some cheese plants by a costly concentration procedure using vacuum evaporators.

68-0821

Roberson, J. E. Bark burning methods and operating experiences. *Combustion*, 39(7):17-19, Jan. 1968.

Some guides and considerations that might assist prospective bark-boiler purchasers in the selection of equipment are discussed. The most important points are: bark burning capacity of boiler should be adequate; bark should be properly sized; a controlled flow rate of bark to the boiler should be provided; careful selection of burning equipment; careful selection of furnace size and proportion; careful selection of dust collection, overfire air, and reinjection equipment; provision of complete and full information to the equipment supplier regarding (a) steam flow fluctuation, (b) bark flow fluctuation, (c) bark moisture variation, and (d) character of the mill that would affect the equipment; and proper operation and maintenance.

68-0822

Robinson, H. Refinery hires dredger to remove sludge. *Water and Wastes Engineering*, 5(10):64-65, Oct. 1968.

A plant which consumes over 100 million gal of water per day produces waste water amounting to nearly 30 million gal daily. This must be treated at the refinery waste treatment complex. One phase of the treatment consists of a 6-acre basin containing a presettling compartment and four 1 1/4-acre bio-oxidation basins. Over a period of time, heavy matter forms sludge in the bottom of each bio-oxidation basin. A portable hydraulic dredge, 22-ft long by 8-ft wide, was selected to clean the tanks and it proved to be both fast and efficient. The sludge is discharged into thickening pits and later removed to a final disposal area.

68-0823

Rock sludge may purify mercury-polluted lakes. *Engineer*, 225(5858):688, May 3, 1968.

Waste rock sludge from ore concentration plants has proved to be capable of binding ions of mercury salts, and may thus become one way of combating mercury pollution of waters. Tests carried out by the Swedish Institute of Water and Air Conservancy Research showed that sludge and mercury form

a thin, harmless 'film' on the bottoms of lakes which gradually becomes embedded in the sediment layers. Subsequent comparative analyses of the mercury content of fish caught near outlets from ore concentration plants, and fish from control waters, showed that the former contained only 0.01 mg per kg, whereas the latter held 1 mg per kg. Biologically, the sludge is said to be innocuous and could be used for fighting mercury pollution in a number of exposed lakes and water courses of minor size.

68-0824

Roennefahrt, K. W., and U. Paul. The biological purification of waste water from animal carcass utilization plants. *Wasser Luft und Betrieb*, 12(1):34-37, Jan. 1968.

The waste water from animal carcass utilization plants contains large amounts of organic impurities which can be eliminated only by biological purification. Purification in percolators, or natural purification in sludge pools is not possible because of the odors which would be produced. An exception is percolators which contain a plastic material (for instance, floccor). Such percolators can serve as a first biological stage. Cyclones and grease extractors, as well as pre-purification tanks, should precede an activated sludge plant. The pre-purification tank must be covered to avoid annoying odors in the neighborhood. The size of the aeration tank depends on the daily BOD of the mean organic pollution of the waste water, and the desired decomposition rate. In an animal carcass utilization plant in the Saar area, an aéro-accelerator in activated sludge stage has produced satisfactory results. In the last few years, surface aerators have been installed in biological purification plants. Waste water purification in animal carcass utilization plants using the biofloc method is illustrated in a schematic drawing. Another means of purifying the waste water from such plants is the gyrofloc method. It is also illustrated in a schematic drawing. The sludge which accumulates during biological purification should be dehydrated and subjected to a fermenting process before it is spread out in drying beds, again because of odors. The amount of sludge which accumulates daily depends on the BOD reduction and on the degree of pollution. Sludge stabilization might also be possible, but no experience has yet been gained for these types of sludges. In the United States and in the German Democratic Republic, animal food is made of the activated sludge. The costs for such purification plants are between DM 500 and 1,000 per kg BOD. Operating costs are low because they involve only the costs for the electric current required to operate the aerators. Generally they are approximately 0.5 to 1.0 kwh per kg BOD. (Text in German)

68-0825

Rose, B. A. Sanitary district puts sludge to work in land reclamation. *Water and Sewage Works*, 115(9):393-399, Sept. 1968.

The Chicago Sanitary District has an experimental soil improvement and reclamation program which puts digested sludge to work forming top soil, and fertilizing and irrigating crops. This is to provide disposal for more than 900 tons (dry basis) per day of sludge. The present methods—heat drying, wet air oxidation, heated digestion, Imhoff tanks—were considered too expensive, created too much air pollution, failed to make use of nutrients, caused significant problems

in the waste water treatment process, and required a dump capacity of 600,000 cu yd per year. The proposed solution to the problem is land reclamation. Digested sludge would be piped through high-pressure pipelines to reclaim 50,000 acres of poor farmland. It would be applied to the land through irrigation systems, tilled into the soil, and farmed on a rotating basis. Studies indicate that it will cost about \$22 per dry ton to dispose of sludge in this manner. Experiments are underway to determine optimum use of this method.

68-0826

Ross, R. D. *Industrial waste disposal*. New York, Reinhold Book Corporation, 1968. 340 p.

This volume presents a 'systems' approach to industrial waste disposal. It is concerned with the evaluation of any waste disposal and the proper selection of a process and associated equipment to solve the problem. It is designed to provide the engineer with general information about the lesser known processes and operations used for waste disposal. Each section presents some brief theory, a discussion of the practical aspects of the particular waste problem, and a description of the equipment and its economics. The equipment and systems discussed are those which would not ordinarily be included in an engineering text. The areas discussed are those in which the empirical information gathered over the past decade are of prime importance. Areas covered include: waste gas treatment; waste liquid treatment; incineration; final disposal; radioactive waste management; and a general compilation of air and water pollution regulations.

68-0827

Ross, R. D. Waste gas treatment. In *Industrial waste disposal*. New York, Reinhold Book Corporation, 1968. p.11-98.

The gaseous waste stream may contain particulate matter, ranging from submicron size to almost any size that would be carried in a gas stream at the velocity in the exit duct. The waste gas may also contain liquids either entrained as droplets or vapors, or it may be a pure gas that contains neither liquid nor particulate matter. A primary treatment process will produce two products, one a gas and the other a liquid or a solid. The liquid or solid may require further treatment, or may be valuable for direct re-use or for sale as a by-product. All of the primary treatment processes are covered, including: mechanical collectors, electrostatic precipitators, fabric filters, wet scrubbers, condensers, and activated carbon adsorption vapor phase systems. Application areas, operating principles, design parameters, mechanical design, sample calculations, diagrams, and data are included for each of these processes. Capital investment and operating costs are considered as air pollution control requirements. A list of references by each author is provided.

68-0828

Ross, R. D., R. A. Conway, D. L. Warner, et al. Final disposal. In *Industrial waste disposal*. New York, Reinhold Book Corporation, 1968. p.240-273.

Final disposal means that the ultimate effluent from a processing plant will be returned to the earth, the sea, or the atmosphere in such a way that it will not adversely affect

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them now or in the future. Waste gases, which are not toxic or dangerous in any way to health or property, may be released into the atmosphere. Many liquid wastes may be safely dispersed into large bodies of water by providing proper methods which insure very dilute concentrations within a short distance of the effluent pipe. Deep well disposal of more difficult wastes, such as radioactive wastes, is possible providing there is no danger to watersheds. Solid materials which are sanitary in nature and suitable for compaction into sanitary landfill may be disposed of in this manner with proper regard to topography. Dispersion methods, deep well disposal, burial and landfill, and odor control of wastes are all considered in depth with diagrams, maps, and lists of pertinent data. References are provided for each of these topics.

68-0829

Ryan, M. J., and R. L. Miller. Batch-feeding studies on high-solids activated sludge for treating concentrated human waste. Report No. SAM TR-68-108. Texas, Brooks Air Force Base, USAF School of Aerospace Medicine, Sept. 1968. 15 p. (Distributed by National Technical Information Service, Springfield, Va., as Publication No. AD 681 127.)

Batch-fed or intermittently-fed activated sludge cultures can be acclimated to handle human excreta with little dilution. During a 40-day continuous run, a prototype sludge reactor was fed batchwise (daily) with an increasing quantity of mixed human waste. Removal of chemical oxygen demand, and the quality of the clarified process effluent were monitored as functions of time and the feeding rate. Results showed that at a loading rate of 5.0 g COD per liter culture, approximately 80 percent of the feed COD was removed after 23 hr of processing. Both the capacity for COD removal and the quality of the process effluent were found to be strong functions of air supply rate. Recommendations were made regarding the use of a continuous feed system for better optimization of the uptake rate.

68-0830

Sanzin, W. D. Biochemical reaction mechanisms in anaerobic sludge reduction. *Zeitschrift fuer Wasser und Abwasser Forschung*, (6):246-250, Nov.-Dec. 1967.

As anaerobic sludge reductions under natural conditions showed (at the bottom of a river or a lake, for instance), methane bacteria are the main decomposing elements in the process. The biochemical reactions needed to decompose organic substances were observed in laboratory reduction chambers (partly with the aid of the C-14 tracer method). The reduction takes place in two steps. First, the main components of the sludge, i.e. albumins, carbohydrates, and fats, are reduced to alcohols, lower fatty acids (especially acetic acid and propionic acid), carbon dioxide, and hydrogen. The organisms responsible for the reduction process at this stage are yeast, lactic acid bacteria, propionic acid bacteria, butyric acid bacteria, butyl and aerobacter bacteria, as well as proteolytic and lipolytic microorganisms. Second, the methane bacteria complete the reduction of the main sludge components to methane, ammonia, and carbon dioxide. It was found that the temperature has a profound influence on the duration of the reduction process. It took 50 days to decompose the sludge at a temperature of 10°C, but only five days at 30°C. (Text in German)

68-0831

Schink, C. A. Plating wastes: a simplified approach to treatment. *Plating*, 55(12):1,302-1,305, Dec. 1968.

The chemical treatment of the effluent from a metal etching, plating, and anodizing operation is described. Sulfur dioxide and chlorine are added directly into the hexavalent chromium destruction and cyanide oxidation tanks without the use of sulfonators, chlorinators, metering pumps, or valves. The effect of gravity is used as much as possible. The plant is essentially automatic in operation. The insoluble residues are removed by settling in a three-compartment lagoon. It is necessary to remove the solids from the lagoon into drying beds two or three times per year. The dried solids are a clay-like material which is ultimately used for landfill.

68-0832

Scientific Chemical Treatment Co.: improving the industrial environment. *Delaware Valley Industry*, 41(3):20-22, Mar. 1968.

Scientific Chemical Treatment Company, Elizabeth, New Jersey, buys, processes, and disposes of off-specification or contaminated chemical and industrial by-products. It has the experience to make the most economical recommendations, and it designs, engineers, and constructs specialized facilities to process the material either on the client's property or at Scientific's facilities at Carlstadt, New Jersey. A subsidiary, North Jersey Refining, has sophisticated distillation facilities with a better than 200,000 gal capacity. Its equipment includes a new phosphoric acid methanol recovery unit. An advanced high and low temperature thin-film solvent recovery system, along with corrosion-resistant vacuum distillation columns, is currently being installed. A new recovery unit for copper has just gone into operation. N.J. Refining buys from industry, reprocesses, and sells the products to users throughout the country. A greater portion of its work is for customers who re-use the material themselves and pay a fee for distillation services. Kin Buc, another subsidiary, operates a huge facility in Edison, New Jersey, which handles refuse from 13 central New Jersey communities. Eastern Industrial Corporation, a Philadelphia-based subsidiary, specializes in industrial waste removal and handles the direct collection and disposal aspects. Containerization and specialized trucks are part of the equipment. For the future, the company will concentrate on the recovery of chemicals as a method reducing air and water pollution. Chemical solvents and hydrocarbons, which are responsible for much of the industrial smog problem, will be recovered and re-used.

68-0833

Scroggins, T. L. Use of wood residues in Oregon for pulp and composition board. Corvallis, Oregon State University, School of Forestry Research Laboratory, Oct. 1968. 16 p.

Data was gathered concerning the usage of chips, sawdust, and shavings in the pulping and composition-board industry during 1967. Estimates of the amounts of these residues that will be used in 1968 and 1969 were also made. A large increase in residue utilization occurred in Oregon during the last 14 years. In 1967, the pulp mills dominated the chip market, but most of the shavings were used by the composition

board plants. Use of shavings for pulp may increase as more mills obtain sawdust digesters that can also use shavings. Sawdust is an incidental part of the raw material for composition board. Approximately 32.6 percent of the wood residues produced in 1967 in Oregon were exported beyond the State's borders. The greatest effect upon supply and price of wood residues has been the exportation of chips to Japan. During 1968, the demand for sawdust by all Oregon industries increased 142 percent and the demand for shavings by 28 percent. During 1969, the chip requirements might exceed the capability of the primary forest industries. To fill the demand for the 1970's, the board and paper industries will have to develop new sources of fibers such as: species of trees not utilized or only partially utilized; thinnings from tree farms; or harvesting of cull logs and slash.

68-0834

Seidel, M. Some problems in the elimination of refinery residues. *Wasserwirtschaft-Wassertechnik*, 18(5):151-155, May 1968.

About 200,000 to 300,000 tons of refinery residues accumulate annually in the German Democratic Republic. The most favorable, and also the most economical use or elimination of some of the refinery residues are discussed. Liquid or viscous acid sludges from the refining of lubricants, motor oils, petroleum jelly, etc., are best eliminated by incineration. Among the various methods which have been developed, the incineration of acid sludge mixed with soft coal dust has proved the most efficient. The mixture can be used either to heat boilers or as fuel in the gypsum sulfuric acid process. The lye which is used to desulfurize gases must be replaced once a year by fresh lye. Regeneration of the spent lye is too expensive, and dumping is too dangerous. Thus only incineration can be considered. However, the potassium sulphate formed by the incineration process has been a problem until 'cold incineration' developed by Boie was introduced. The principle used in this system is schematically illustrated. A radiation tank is attached to the combustion chamber, whose convection heating panel is set into vibration to avoid a sulfate deposition at this point. The potassium sulfate is precipitated only after the waste gas has been cooled. Residues from the Varga hydro cracking method, which have a solids content of about 30 percent by mass, are sprayed into a turbulent layer of heat resistant ceramic material. A light heating oil, free of solids, is gained by this process, and iron oxide dusts remain which can be dumped. Residues from styrol synthesis are mixed with heating oil in a ratio 1:1, and are then used as fuel for steam generation, or for some other purpose. The incineration of residues such as bitumen and tar is briefly discussed. All elimination methods are illustrated in diagrams. (Text in German)

68-0835

Septic tank dumping. *Water and Waste Engineering*, 5(3):22, Mar. 1968.

A roundtable discussion answered the questions: do companies that perform septic tank or cesspool cleaning dispose of their wastes into municipal sewer systems; must permission be obtained before dumping; is dumping allowed in the treatment plant; is dumping supervised by municipal personnel; is a fee charged; does dumping cause any problems

in the municipal system or treatment plant? No dumping was permitted by 19 municipalities reporting. Other answers indicate that permission must be obtained before dumps are made; there is usually supervision of municipal personnel; fees were charged in most cases; and the dumping of industrial wastes did not cause problems in most cases.

68-0836

Sewage disposal by Pasveer ditch at Tamworth. Surveyor and Municipal Engineer, 132(3973):19-20, July 1968.

A temporary disposal plant using the Pasveer principle was designed as an interim measure to handle 300,000 gpd until a new sewage works comes into operation. The inlet bay of the Pasveer plan comprises a gauging flume, a comminuter, and a by-pass screen. The oxidation ditch has a capacity of 600,000 gal with a retention period of 48 hr at design dry weather flow. Concrete fencing units were used to line the ditch, which was composed largely of fill. A vertical concrete fence was constructed up the center of the ditch to provide a continuous path around the ditch. Two lines, each consisting of three cage rotors were provided. An overflow weir is provided at the end of the ditch where liquor is overflowed to a single circular final effluent tank having a capacity of some 54,000 gal or 4.3 hr retention time. A helical scraper is installed in the tank and is operated continuously. Effluent is then fed to an irrigation area some 2 acres in extent, collected in a gravel drain and then discharged into a brook. Sludge is drawn off continuously from the base of the settlement tank, and flows by gravity to the inlet bay of a sludge wheel which returns sludge to the main oxidation ditch. Five drying beds, having a total area of 1,380 sq yd are provided. The sludge content of the ditch has built up progressively over 4 months to 3,000 ppm suspended solids, as compared with an optimum 4,000 ppm.

68-0837

Shah, I. S. New evaporator-scrubber systems improve kraft recovery process. *Paper Trade Journal*, 152(12):58-64, Mar. 18, 1968.

In the two-stage evaporator-scrubber system, the two functions are performed separately in two stages: the first stage is a low pressure drop evaporator, and the second stage is a scrubber. Pilot plant experimental work has proved that the S-F venturi is an efficient evaporator and scrubber from the viewpoint of efficiency and ease of operation. Dust collection efficiencies of 99 percent can be attained at low pressure drops. Other advantages of the S-F type venturi are the absence of wet-dry conditions, nozzles are not required, and this type venturi has a self-cleaning feature due to its swirling liquor action. Tables summarizing the operating performance data for the two-stage evaporator-scrubber system, and for a single-stage scrubber system, are included.

68-0838

Shah, I. S. Recovery of heat and chemicals from kraft furnace flue gases. *Paper Trade Journal*, 152(11):65-67, Mar. 11, 1968.

The operation, advantages, and disadvantages of the cascade-precipitator system, cyclone-precipitator system, and venturi evaporator scrubber system for the recovery of heat

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and chemicals in the kraft pulping industry are discussed. The release of sodium compounds and sulfur-bearing malodorous gases is also discussed. In spite of its comparatively low dust collection efficiency and high operating cost, the venturi evaporator-scrubber system has been accepted by the pulping and paper industry because of its low capital investment, low maintenance, and high heat recovery.

68-0839

Shannon, E. S. Underground disposal of activated sludge. *Journal of the Water Pollution Control Federation*, 40(12):2,050-2,061, Dec. 1968.

The disposal of excess activated sludge from an activated sludge section of a 60-million-gal-per-day (227,100 cu m per day) liquid wastewater installation in Midland, Michigan, is accomplished by deep-well disposal. The disposal well system consists of a 100-ft-diameter thickener tank, two sludge holding tanks, one sludge forwarding station, four high-pressure pumps, and two disposal wells. Only one pump and one well are operated at a time. The Dow well, which is illustrated, has an extra casing to control corrosion of the pipe through the glacial drift, and the inner annulus, between the casing and injection tubing, is filled with a corrosion resistant aqueous solution. The pressure is monitored to detect leaks which may occur in the injection tubing.

68-0840

Sheffield overcomes sewage disposal problem. *Engineer*, 226(5886):740-741, Nov. 15, 1968.

An incineration plant of Nichols design has been installed to overcome disposal problems and reduce the costs of transporting about 75,000 tons per year of sewage sludge in the form of pressed filter cake. The new Sheffield plant, designed to treat 400 tons per day of pressed sewage sludge filter cake, has two 22-ft 3-in. diameter furnaces. A drawing showing the design of the multi-hearth incinerator is reproduced. Once the furnace is heated by oil burners, the sewage sludge contains enough fuel to enable it to continue burning. Above the top burning hearth there is an empty chamber containing afterburners to raise the outlet gas temperature and thus eliminate odors. Discharged ash is stored in a bunker and then loaded up to 15 tons per hr into lorries, after it has passed through a wetting drum.

68-0841

Shell adds to waste treatment at Houston. *Water and Sewage Works*, 15(4):183, Apr. 1968.

Shell Chemical Company has reported to the Texas Water Quality Board in Austin that construction is underway on a secondary waste water facility at its Houston plant. The primary processes include acid-base neutralization, oil separation, flocculant-aided settling, and air flotation of suspended materials. The new secondary facility utilizes the activated sludge process. In two large aeration basins, primary treated water will be mixed with activated sludge which consumes the organic materials dissolved in the waste water. Seven aerators will agitate the water in each basin, providing the oxygen needed to carry out the biological treatment process. After a retention period of about 20 hr in the

aeration basins, the waste water flows to clarifiers for further flocculation and settling. Sludge will be concentrated, dried, and disposed of at the plant as landfill at an average rate of 15,000 lb per day, in addition to 40,000 lb per day from the primary treatment basin. The system will be able to treat 6.0 million gal per day.

68-0842

Singer, P. C., W. O. Pipes, and E. R. Herman. Flocculation of bulked activated sludge with polyelectrolytes. *Journal of the Water Pollution Control Federation, Research Supplement*, 40(Part 2):R1-R9, Feb. 1968.

Bulking was induced in normal, healthy activated sludge by feeding it a synthetic waste containing peptone and glucose. Evaluations were based on the reduction in the Sludge Volume Index of the bulked sludge, the settling rate of the flocculated bulked sludge, the chemical oxygen demand, and the ability of the returned sludge to rebulk and again perform effectively in stabilizing the influent waste. Two cationic polymers (Dow Chemical Co.'s Purifloc 601 and Purifloc 602), and an anionic polymer (Purifloc 501), and alum were used. The optimum concentrations for both cationic polymers were found to depend on the initial sludge volume index and the suspended solids content. The greater the SS concentration, the greater was the polymer requirement and the greater the final settled volume due to trapped water below the solid-liquid interface. The use of cationic polymers will result in the discharge of a clear stable effluent to the receiving stream, as shown by the low SS and COD of the supernatant. The anionic polymer had no effect on the bulked sludge under the conditions studied. Alum was successful in settling the bulked sludge, but at higher concentrations than the organic polyelectrolytes. The respective optimum concentrations for the cationic polymers A and B and alum were 2.0, 3.0, and 50 mg per liter for a bulked sludge, with an SS of about 1,200 mg per liter. Costs of the respective coagulants (A, B, alum) were \$6.50, \$20.00 and \$9.40 in dollars per million gal. Although these cationic polymers can be used to cure an acute case of sludge bulking, their use as a flocculant in continuous flow activated sludge processes has not been established.

68-0843

Sludge digestion problems. *Water Pollution Research Laboratory national survey. Surveyor and Municipal Engineer*, 131(3964):18, May 25, 1968.

Increasing difficulties in anaerobic sewage sludge digestion prompted the Water Pollution Research Laboratory to circulate a detailed questionnaire to all local and main drainage authorities. Of 142 works employing heated digesters, serving 18,750,000 people, only 3.6 percent reported persistent difficulties in digestion, although a further 52 percent admitted to temporary troubles. The difficulties were due, in order of magnitude, to inadequacy of design operation, trade wastes, and anionic detergents. It was concluded that the situation is less serious than has been claimed by critics of the digestion process. Most difficulties appear susceptible to correction. Simple small-scale batch digestion tests, carried out on representative samples of crude sludge produced each day, can provide early warning of toxic discharges. Overloading was a predominant cause of stratification and loss of solids from digestion tanks. The

advantage of the digestion process is that it reduces the bulk of liquid and solids for ultimate disposal and makes them acceptable for widespread disposal on land.

68-0844

The sludge dilemma. *American City*, 83(12):73-74, Dec. 1968.

The most common method of handling sludge at wastewater plants consists of anaerobic digestion followed by drying on a sand bed. The most common method for sludge disposal used by industry is lagooning. For coastal cities, anaerobic digestion, followed by pipeline transportation to the ocean or land reclamation, provides by far the cheapest method for sludge disposal. For many near-coastal cities with navigational access to the ocean, digestion followed by barging offers the most economical method of disposal. Marketing dried wastes sludge has generally been a failure. Sludge treatment presents many operational problems involving odors, inefficient solids capture, constant supervision, and general lack of scientific controls. Almost all methods of sludge handling and disposal now used were known in 1930. Although few large cities use sand beds for sludge drying because of space requirements, it is still the most common method in use today.

68-0845

Sludge disposal from water treatment plants. *Surveyor and Municipal Engineer*, 131(3969):31-32, June 29, 1968.

The type of waste from water treatment plants which is considered here, is the settled sludge from the sedimentation of water treated with coagulants such as alum, copperas etc. There are three methods of dealing with this: designing of the plant to avoid or to reduce the production of waste; means to reduce the amount of sludge to manageable proportions; methods of treating the remaining quantities of sludge. A sludge disposal process is divided into three parts: a method of primary reduction of volume through stirring, settling, etc.; changing the state of the sludge to one in which a simple disposal process is sufficient; the final disposal of the moist solids or cake. The main methods of treatment of sludge today are vacuum filtration, filter pressing, freezing and thawing, lagooning, and disposal into sewers and rivers. The most likely outlet for disposal in the future will be the water industry itself for the recovery of chemicals from the sludge. Also polyelectrolyte coagulants will produce an entirely different type of sludge with different properties, and as research is on-going in this field, it will become increasingly important to find suitable methods of disposing of the new by-products they will produce.

68-0846

Sludge disposal problems can be solved. *Modern Power and Engineering*, 62(6):72, June 1968.

Advice is given on the selection of sludge disposal processes. It is commonly known that the less water released as waste, the easier the control of this pollution. Untreated sludge may be dumped in abandoned quarries or even on farmland. Sludge treatment can be profitable when reusable or saleable byproducts are found. A few of the recognized methods of sludge drying and disposal are listed. However, as these problems are under investigation, it is recommended that the

engineer keep abreast of new methods. Weather permitting, sludge drying in open air lagoons or drying beds can be successful. Mechanical dryers, using the vacuum or gravity filtration principle, remove a percentage of free water, thus allowing for easier sludge handling. The cost of heat drying restricts its use to sludge yielding high resaleable material or expensive ingredients to be reused for inplant processes. Incinerators can also be used to eliminate sludge. Digestion is an anaerobic biological treatment for wastes having a high proportion of organic material. The sludge is pumped into airtight drums, and when treated at an appropriate pH, the sludge rapidly decomposes into methane and carbon dioxide which can then be utilized as fuel to heat the digestion tanks. The pumping of water waste from industry into deep underground deposits of salt water-bearing limestone is mentioned.

68-0847

Sludge freezing plant. *Journal of Refrigeration*, 11(5):114, May 1968.

The refrigeration engineers of the Hall-Thermotank Group Company, J & F Hall Ltd., will install a sludge freezing plant for the Daer Water Board in the extensions to the treatment works at the Daer Valley Reservoir. The new plant, designed to handle 6,000 gal of sludge per 24 hr, will operate on the principle that slow freezing of the sludge causes breaking down of its colloidal structure, greatly accelerating the precipitation of the insoluble matter in the solution. The stainless steel tanks will be defrosted by hot gas, one tank defrosting while two others are freezing, the fourth being held as standby. The Daer Water Board plant is believed to be the first in the British Isles with provision for recovering and reusing the alum from the supernatant liquid after settling in the sump.

68-0848

Sludge treatment and disposal. *Water and Waste Treatment Journal*, 12(4):123-124, Nov.-Dec. 1968.

The method used by the Sheffield sewage treatment plant at Blackburn Meadows up to a few years ago, was to dewater raw sludge from the primary settling tanks in large lagoons and then to convey the thickened sludge by rail to a tip some miles away. In order to cut down the volume of sludge so that the tipping site could be extended in its useful life, a sludge pressing plant was installed. An odor problem was met by the installation of a multi-hearth incineration plant designed to deal with the pressed sludge cake. The cost of the dual system is not yet known. Concern is being expressed by local authorities with respect to the concentrations of synthetic detergents in sewage and sewage sludge, and the effects of these materials on the sludge digestion process. As far as the sludge digestion process is concerned, it is essential that manufacturers of synthetic detergents make every effort to produce materials that are biodegradable. Improvements in sludge digestion are compared.

68-0849

Small capacity mobile sludge drying plant. *Surveyor and Municipal Engineer*, 131(3962):36-37, May 10, 1968.

The Wickham disc filter was tested on a raw primary sludge from domestic sewage with no trade wastes. The method of

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operation of the disc filter is described, and factors affecting running costs, output or dryness of cake produced are listed. It is estimated that the production model will have an output of 55.75 lb per hr of dry solids. The machine provides a novel, economical, and satisfactory method of treating sludge at small works, according to these field tests.

68-0850

Small purification plants. *Chemie-Ingenieur-Technik*, 40(6):A267, Mar. 1968.

Small purification plants of the Metoxy type are offered by the Meto-Bau-AG, Wuerenlingen, Switzerland. They come in steel, plastic, or concrete. The plant operates according to the principle of total oxidation with large bubble aeration. They can purify communal waste water from smaller municipalities (up to a population of about 2,000) or from vacation resorts not connected to a sewer system. A crusher cuts the solids into particles of about 3 mm. From the activating stage, where the aerobic decomposition takes place, the activated sludge and the water go to a post-purification stage. Here, the activated sludge settles and the purified water, freed of all putrescible substance, flows into the river. The operating costs involve only the energy costs. A weekly maintenance service in the form of a check-up is necessary. The stabilized sludge has to be removed only once or twice a year. (Text in German)

68-0851

Snook, W. G. G. Marine disposal of trade wastes. *Chemistry and Industry*, (46):1,593-1,598, Nov. 16, 1968.

The improved construction techniques which have been developed and the research, development, and experience in the design and operation of submarine outfalls has led to increased use of the technique. The elements considered in the design of such a system are given in detail, through illustrations and graphs from reports of various experimental work. A hydrographic survey and investigation is necessary following acquisition of pertinent data. The type and analysis of effluent, the quantity involved, and details of existing collection and treatment systems should be known. Several examples of construction of appropriate pipelines are given; the majority of the pipes used are welded mild steel, usually with some type of lining. Economic considerations and time required for construction are considered.

68-0852

Somers, J. A. The relation between sludge volume index and sludge content in the activated sludge process. *Water Research*, 2(8):563-573, Sept. 1968.

At the Research Institute for Public Health TNO, Delft, Netherlands, settling tests for activated sludge were carried out in 1-liter measuring cylinders with a diameter of about 5.8 cm, and later in cylinders with a diameter of about 7.8 cm. The sludge volume index (SVI) of the mixed liquor from four activated sludge plants (oxidation ditch-type) was determined for several sludge contents. The values proved to be influenced by the sludge content. With an increasing sludge content, there first appears to be an increase of the SVI due to impeded settling, followed by a decrease of the SVI due to limitation of the settling volume. Furthermore,

the determination of the SVI is influenced by the diameter of the settling cylinder.

68-0853

Sparr, A. E. Sludge handling. *Journal of the Water Pollution Control Federation*, 40(8):1,434-1,442, Aug. 1968.

Sludge handling processes are considered from the viewpoint of the wastewater treatment plant operator. Problems involving sedimentation tanks, sludge digestion, and sludge drying beds are reviewed. Sea disposal is frequently the most economical and simple method available for ultimate sludge disposal for wastewater plants located close to the ocean. A promising new method of chemical treatment of sludge utilizes the application of a heavy chlorine dose to liquid sludge, which renders the sludge inoffensive, stable, and readily dewaterable. Mechanical dewatering can be accomplished through the use of vacuum filters, filter presses, centrifuges, and gravity devices. The two broad fields of incinerators in use are the pressure cooker type and the open flame units. Multiple hearth, cyclone, and fluidized bed incinerators are described and illustrated.

68-0854

Spicka, I. Fluctuation of effluent quality from activated sludge plant. *Water Research*, 2(1):52-53, Jan. 1968.

The effect of BOD and COD loadings, and detention periods on the diurnal and hourly fluctuation of effluent BOD, filtrate BOD, COD, filtrate COD, and VSS was investigated. Experimental data has been obtained for five years of full-scale research in two activated sludge plants. Experimental series were carried out with activated sludge stabilization, the conventional activated sludge process, and the high-rate activated sludge process; sufficient attention was given to analytical and operational control to justify detailed statistical analysis of the results. Relationships are proposed for a variety index and a resistance index. Some typical results obtained from the variations of these indices are presented. The cyclic variation of effluent VSS from extended aeration was noted. The results indicate new possibilities for appropriate estimation of various modifications of the activated sludge process.

68-0855

Spohn, E. Where to put the sewage sludge? *Staedtehygiene*, 19(8):166-168, Aug. 1968.

Sewage sludge may be used for agricultural purposes, may be incinerated together with solid wastes, or may be pumped to the North Sea. Sewage sludge without any treatment is quite unusable in agriculture. There is, however, one method which is ideal—the composting of sludge together with solid wastes. They complement each other quite effectively; solid waste has carbon containing substances and sewage sludge has nitrogen compounds. Three units of waste are combined with one unit of sludge. The mixture is then compacted and formed into briquettes. They are stapled and left to the biologic decomposition process which sets in and dries them completely. After this process, they can be stored in the open air. In due time they are taken from the storage place, shredded, freed from glass splinters, and used as fertilizer. The non-compostable residues (10 to 20% in domestic

wastes) are either dumped, or if no dumping site is available, must be incinerated. The ash is added to the compost. Before subjecting the sewage sludge to the composting process, its water contents must be reduced from 95 percent to 60 or 70 percent. This is done in the city of Schweinfurt, Germany, by using organic flocculants and a filter. After it has been compacted together with the solid wastes, the sludge has lost its annoying odor. In Schweinfurt, the composting plant is located next to the water purification plant. In the city of Blaubeuren, West Germany, the sludge comes from drying beds and must be stored which causes unbearable annoyance through odors. To avoid this, organic flocculants were added to the sludge in the drying beds. (Text in German)

68-0856

Stabilized chlorine dioxide for odor control. Public Works, 99(4):166, Apr. 1968.

When a blower failed at the carefully operated activated sludge plant in Phillipsburg, New Jersey, the remaining blower was unable to maintain aerobic conditions in the aeration and final settling tanks, and odors developed. Anthium dioxide, a stabilized aqueous form of chlorine dioxide, was added to the aeration tank effluent by a simple pet cock arrangement on the drum and a drip feed. The product was fed at the rate of 1.3 mg per liter for the next 41 days. As a result, odors diminished.

68-0857

Swanwick, J. D., A. M. Bruce, and K. G. Vandyke. Inhibition of sludge digestion by synthetic detergents. Water Pollution Control, 67(1):91-99, 1968.

Investigations into the failure of sludge digesters, which appears to be associated with synthetic detergents, are examined. The inhibitory effect is examined and experiments dealing with various concentrations of detergents detail the effect of the detergents. The effects of 'hard' and 'soft' detergents were compared, and similar results were obtained. The effects on sludge solids relationships and secondary sludges were also examined. The use of long-chain aliphatic amines for the removal of anionic detergents was examined and tested, and the results are graphed. When difficulties resulting from detergents occur, they can be quickly rectified by the addition of amine.

68-0858

Swarf handling made easier by new conveyors. Australian Engineer, 1968(2):39, Feb. 1968.

Machine shops would benefit from the installation of this swarf-handling conveyor that could keep machines and surrounding areas clean throughout operation without interruptions to machinery or special costly manual cleaning. Sandvik steel band conveyors incorporate a unique, but simple, arrangement of load control, utilizing a new design trough profile and rubber retaining strips bonded to each side of the band. This means that the steel band is actually wider than the bottom of the trough, and the swarf is deposited more centrally on the conveying surface, away from the edges.

68-0859

Tauber, F. Exhibit 'Water 1968' in Berlin. Staedtehygiene, 19(7):149-151, July 1968.

The exhibit 'Water 1968' in Berlin, Germany, was not only of interest to waste water experts, but also to all of those concerned with the elimination of solid wastes. The Badische Anilin & Soda Fabrik displayed an organic flocculant 'Sedipur' which shortens the drying period of sludge from 3 months to 7 days. Percolators containing plastic material have been developed by Deutsche Babcock und Wilcox AG. An important item was the Seiler-Koppers plant which dehydrates sewage sludge, with a water content of 70 to 97 percent thermally, in one step. At the end of the process the water content has been reduced to 5 to 15 percent. The dried material can be used as fertilizer. The Passavant Werke exhibited new sludge drying and incinerating plants. (Text in German)

68-0860

Tench, H. B. Sludge activity and the activated-sludge process. Water Pollution Control, 67(4):408-420, 1968.

The sludge activity theory given here states, in the form of an equation, the relation between the active and total masses of activated sludge. The basic concepts of the equation are that the rate of purification of sludge is proportional to the active mass of the microorganisms present, that this active mass grows at a rate which is dependent on the rate of oxidation of the impurities, and that it is destroyed by endogenous respiration at a rate proportional to the quantity present. Therefore, there is a maximum active mass that can be held in a plant, and this is attained when the rate of growth is equalled by the rate of destruction. The assumptions made, the derivation of the equation, the practical implications of the theory, and experimental evidence in support of the theory are given. The results are discussed at length in relation to other work in the field. Data used in the experiments are given and some results are plotted.

68-0861

Thomas, R. E., W. A. Schwartz, and T. W. Bendixen. Pore gas composition under sewage spreading. Soil Science Society of America Proceedings, 32(3):419-423, May-June 1968.

Septic tank effluent was applied to sand in laboratory lysimeters. Dosing frequencies of 2-per-day and 6-per-day were used to observe relationships between changes in the composition of the pore gas and clogging of the sand. The rate of clogging in the 2-per-day unit was less than that in the 6-per-day unit. This reduced rate of clogging was related to pore-gas and moisture content changes which occurred in the sewage dosing and drainage cycles. The longer cycle of the 2-per-day frequency provided more oxygen over a greater percentage of the total elapsed time. In the 6-per-day lysimeter, the rapid soil clogging, which is characteristic for anaerobic conditions, started while the oxygen concentration in the pore gas was greater than 13 percent. Water-filled pores or water films, occurring as the result of an increase in the moisture content, may have provided anaerobic sites in the presence of the high pore-gas oxygen. Carbon dioxide inhibition of microbial growth did not cause the rapid phase

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of clogging. Moisture or oxygen determinations may be suitable guides for the prevention of the rapid phase of soil clogging.

68-0862

Thomas, W. R. P., and J. B. Goodson. Expanded municipal wastewater plant provides citrus waste treatment. *Public Works*, 99(5):91-92, May 1968.

The new wastewater plant of the City of Leesburg, Florida, was designed to provide a high degree of treatment for combined domestic and citrus processing wastes. Since domestic sewage contains excess amounts of nutrients that are lacking in citrus wastes, an extended aeration modification of the activated sludge process was selected for treatment of the combined wastes. A flow sheet for the completed plant is shown. Excess sludge is transferred to the clarifier of the old primary plant for thickening and ultimate disposal. Digesters and drying beds of the old plant are also used for waste sludge disposal. Treatment facilities were designed for 2.5 mld of domestic sewage with a five-day BOD loading of 3,000 lb per day and 0.85 million gal per day of citrus waste with a BOD loading of 5,000 lb per day.

68-0863

Trash handling and disposal. *Modern Materials Handling*, 23(8):62-75, Aug. 1968.

The methodology of trash handling and disposal is in a state of transition. Indicators for the future say that the volume of trash will continue to grow, labor costs will continue to rise, anti-pollution laws will become more encompassing, and land for dumping will become scarcer. Compaction of trash has provided a temporary solution, but government and industry are looking for more efficient ways to get rid of the nation's trash. Chrysler's new assembly plant in Belvidere, Illinois, produces 200,000 cars a year, with one ton of total waste for disposal or salvage yielded for each car. Chrysler's revenue from the sale of scrap amounted to \$40 million last year. Its success is due to a central organization for planning optimum disposal, mechanization of waste disposal by stationary compactors, hoppers and balers, no costly incinerators, flexible arrangements with contractors, and a program to reduce trash-generating packaging by suppliers. Pontiac Motor Division of General Motors, illustrates the problems of trash handling by an existing plant in a built-up area. Its answer was twofold: compaction of trash to reduce the number of trips to the dump; and turning over the hauling disposal operation to a private contractor. Integrated equipment systems are given for handling various volumes of trash at short and long haul distances. A review of collection and processing equipment is given with suggestions for selection.

68-0864

Treatment of effluent and trade wastes. *Chemical Processing*, 14(10):88, Oct. 1968.

The settled sludge from a plating shop effluent treatment plant in Birmingham, Great Britain, F-8, in the past, been collected in tankers and dumped. There are now 16,000 gal per day of weak sludge to be disposed of, with consequent

high tanker costs and organization problems. An effluent handling plant was designed to include two 78-sq ft rotary vacuum precoat filters. The filters are arranged to take a feed of sludge containing 1 1/4 percent solids from the neutralizing plant, and produce from this a clarified filtrate for discharge to a sewer and a handleable cake suitable for disposing by dumping. Now 28 tons per week of filter cake are collected and dumped by lorry. Further treatment of the cake for metal recovery may be considered.

68-0865

Vater, W. Meeting 1967 of the Waste Water Technical Association in Duisburg, Germany. *Wasser und Abwasser*, 109(8):205-207, Feb. 1968.

The Waste Water Technical Association (ATV-Abwassertechnische Vereinigung) held its biennial meeting in Duisburg. Among the numerous reports was one about the disposal of solid wastes. It described the purification of industrial waste water by E. Merck AG. The company, with approximately 6,000 employees, produces chemicals and pharmaceuticals. The waste water is brought to a pH value of 6.2 to 6.5 by the addition of lime milk before proceeding to the mechanical purification stage, where it is stored for 36 hr in three tanks. Then it enters the biological stage which consists of three aeration tanks (aeration lasts 4.5 hours). The sludge that accumulates in this purification process has been quite a problem. The sludge from the mechanical stage is not putrescible and the excess sludge from the biological stage has a high water content. Both types must be burned in a rotating tube furnace after they have been thickened and mechanically dehydrated. Prior to mechanical dehydration, the sludge is mixed with chromium-containing waste water, iron sulfate, lime, and ash from sludge incineration. The 10 tons of ash which remain daily from the incineration are carried off to a dumping site. The cost for the entire plant was about 16 million DM; the operating costs are 0.36 DM per cu m purified waste water. (Text in German)

68-0866

Vogel, H. E. Association of Swiss waste water experts. *Gas und Wasserfach, Wasser, Abwasser*, 109(22):606, May 1968.

The Association of Swiss Waste Water Experts held a meeting on April 5, 1968, at which the history of the construction of waste water plants in St. Gall, Switzerland, was traced. In 1905, plans were made to collect the waste waters from the central part of the city and take them to the Sitter River. Topography made the project impossible. New sections were added to the city, and in 1939, a new project was worked out, but it was never realized. Today the city of St. Gall has two waste water purification plants and a third one in the planning stage. The waste water plant at Hofen was built between 1913 and 1917 and has been continuously expanded so that it served a population of 68,000 in 1960. The plant operates according to mechanical biological principles. Since 1967, experimental operations with a thermal sludge drying plant have been under way. The plant has a capacity of 1 cu m per hr and the total cost was 1,992,000 Sw Fr. Between 1962 and 1965, a waste water plant, at Patterwald, was built. It also operates by mechanical biological principle. The sludge accumulated is subjected to a rotting process. The total cost of this plant was 2,266,000 Sw Fr. The waste water

plant, at Au, will serve the western part of the city. In its final stage, it will serve a population of 160,000 and operate mechanically and biologically with an activated sludge tank. The sludge remaining after the process will be decomposed. An estimated 26,148,000 Sw Fr will be invested. (Text in German)

68-0867

Walters, C. F., R. S. Engelbrecht, and R. E. Speece. Microbial substrate storage in activated sludge. *Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers*, 94(SA2):257-269, Apr. 1968.

Laboratory systems were used to investigate the biochemical composition of activated sludge, particularly the bacterial carbon-energy storage products. The food-to-microorganism ratio (F/M) exerts an influence on the amount of storage material synthesized. At an F/M ratio of 4.30 g COD per g MLSS per day, the microorganisms contain the highest percentage of two storage products: carbohydrates, and poly-beta-hydroxybutyrate (PHB). Cells grown in systems with greater or lesser F/M ratios do not have as high a percentage of storage material. The COD to nitrogen ratio has little effect on the percentage of storage compounds in the cell, within accepted operational COD to nitrogen ratio limits. The nature of the substrate has a noticeable effect on the nature of the stored material. A source of preformed amino acids, such as yeast extract, along with a carbohydrate, is required to maintain a biological population obtained originally from a treatment plant seed that will synthesize PHB. The ability of an actively stabilizing sludge to remove substrate is influenced by the amount of material stored by the microorganisms. As the cellular storage products decrease during stabilization, the ability of the organisms to remove substrate is greatly increased.

68-0868

Waste disposal for a Ford motor plant. *Public Works*, 99(5):68, May 1968.

Manufacturing wastes from the Ford assembly operations at San Jose, California are to be converted through a new process into usable by-products. A waste converter, to be operated on the Ford property, is designed to reduce to elemental charcoal and usable gases the combustible materials which constitute the bulk of the plant's daily output of 40 tons of refuse. Only non-combustibles will continue to be hauled to the dump, which now absorbs all refuse from the plant. The converter will reduce wood, cardboard, paint sludge and other wastes to commercial charcoal through the application of heat and pressure in a closed atmosphere which is free of oxygen so that combustion can not occur. The process is self-generating since a portion of the gases produced in the process will provide the necessary heat. Unused gases will be dissipated through burning.

68-0869

Waste handling at Hilo. *Water and Sewage Works*, 115(10):451-452, Oct. 1968.

A water pollution control plant in Hilo, Hawaii, was built to protect the marine and recreational facilities of Hilo Bay. The plant will include screening grit removal, primary settling,

sludge digestion, and sludge drying. The first construction phase will have the capacity to treat an average flow of 7 mgd, a maximum of 10.3 mgd and a peak of 16 mgd; the second phase will have the capacity to treat an average flow of 14 mgd, a maximum of 20.5 mgd and a peak of 31 mgd. Screening is accomplished by a Thru-Clean mechanical bar screen discharging into a trough. The screenings are then fed into a shredder and returned to the flow in front of the screen. The flow proceeds to a Link-Belt aerated grit chamber, equipped with a Straightline aerated grit collector. The sludge is digested in one primary and one secondary digester, and then drawn off to two centrifuges, each with the capacity to dewater digested sewage sludge with dry weight solids at 6,160 lb per operation day. The centrifuged sludge is discharged onto a sludge belt conveyor, and then into a disposal truck.

68-0870

Waste treatment and incineration of the Dow Chemical Co. *Waste Trade Journal*, 64(29):4, 10, July 27, 1968.

The Midland Division of Dow Chemical Co. has spent more than \$20,000,000 to improve and expand its waste control facilities, and about \$3,500,000 per year to operate them. The Tittabawassee River supplies Dow with more than 60 million gal per day of water, which must be treated to remove process wastes before it is returned. The wastes from the phenolic process are collected in a 12-acre equalization pond. The effluent from this pond is blended with cooling water from the phenolic production areas to maintain approximately 125 ppm phenol in the feed to the biological treatment units. After clarification, the wastes flow to four trickling filters which remove approximately 75 percent of the phenol and 60 percent of the chemical oxygen demand. The waste then flows to an activated sludge aeration basin where the organic materials are oxidized by microorganisms, producing carbon dioxide and water. During 3 hr of aeration, the activated sludge process removes more than 95 percent of the remaining phenol. The General Treatment Plant removes 95 percent of the BOD and suspended solids. A 53 million gal 'shot' pond has been installed to hold high BOD or toxic wastes. Inorganic wastes from the General Treatment Plant are dewatered. An incineration complex includes burning facilities for both liquid and solid waste materials.

68-0871

Waste treatment by aeration. *Australian Chemical Processing and Engineering*, 21(5):27-29, May 1968.

Some of the main points of a lecture, delivered by R. D. Boutros to an audience of engineers in Sydney, Australia, are reviewed. Aeration is described as a mixing operation involving gas-liquid and liquid solid phases. By use of the Lightnin Aeration Calculator, a design for an activated sludge waste treatment plant can be approximated. Given the waste flow rate, BOD level, sludge loading factor, mixed liquor concentration and return sludge concentration, the calculation of detention time, size of tanks, and total BOD rate can be made. The various methods of control of mechanical aerators are based on change of degree of submergence of the impeller, on or off control of the aerator, and the two-speed motor governed by the oxygen analyzer. The present maximum practicable size of a surface aerator unit is 100 hp.

Industrial Wastes

68-0872

Waste water purification. *Chemie-Ingenieur-Technik*, 40(6):A267, Mar. 1968.

The Degussa Company, Frankfurt am Main, Germany, has developed a new separating agent B 20, which is less expensive than the separating agent B 18 developed in 1967, and has a wider application because it can bind all organic, water insoluble substances (e.g. oil dyes and solvents). B 20 is stirred into waste water at room temperature. After about 5 to 10 minutes, dirt and impurities combined with the separating agent can be easily filtered off. The remaining impurities and the separating agent left in the waste water can be removed in a filter press, a centrifuge, or a drum filter. After that the purified waste water can flow into the drain system. The method is not only for small and medium sized enterprises, but also for large plants which already have a water purification plant. Small amounts of the agent can be added to pre-cleaned waste water, and the last amounts of oil will be removed. (Text in German)

68-0873

Water Resources Engineers, Inc. In-plant treatment of cannery wastes; a guide for cannery waste treatment, utilization and disposal. California State Water Resources Control Board Publication No. 38. Sacramento, 1968. 78 p.

Food processing in California, especially of fruits and vegetables, is one of the State's major industrial activities. The fact that the canning industry is becoming increasingly cognizant of the need to address itself vigorously to waste control problems is amply documented by its increased expenditures for waste treatment, disposal, and utilization. The canning industries have been faced with the realization that both water supply and waste disposal influence growth, operation, and production costs. Water reuse is now widely practiced in the canning industry. The Cannery Research Advisory Committee undertook a 3-year investigation of tomato and peach processing comprised of the following phases: physical, chemical, and biochemical characterization of in-plant waste streams; evaluation of the technical and economic feasibility of in-plant separation and/or treatment of cannery waste flows; and development of techniques for the economic evaluation of potential systems for cannery waste treatment and/or disposal. The 'guide' was prepared from all information developed in the research program. Specifically, the guide seeks to define in general terms, with appropriate examples from actual experience, procedures and techniques for: waste characterization, waste treatment potential, economics of alternatives, and preliminary system design.

68-0874

Werner, A. E. Gases from sediments in polluted coastal waters. *Pulp and Paper Magazine of Canada*, 69(5):61-70, Mar. 1, 1968.

Gas volume and composition at 13 stations in Alberni Harbour, British Columbia, were monitored monthly for 2 years. Analogous measurements were made at all other currently active tidewater pulpmill sites in the province. Seawater and marine mud were incubated, and one of the active microorganisms was isolated and identified. Fermentation gases were removed for chemical analysis.

Pulpwood of differing botanical origin was analyzed and the results were used to construct a stoichiometric model of marine pulpwood degradation. The relation between gas retained in a waste bed, and that released was studied, as well as the relationship between depth and gas retention. It was concluded that the fermentation which wood undergoes in seawater under anaerobic conditions yields an abundance of such gases as methane, carbon dioxide, hydrogen, and hydrogen sulfide. Mapping the submerged waste beds revealed that discharge of wood waste into swiftly moving waters, results in only small sediment beds. Bays, however, are usually unfavorable for waste release. Improved sewage disposal involves maximum retention of wood on land and discharge into well-aerated, swiftly moving waters.

68-0875

Wetmore, C. A. Bark fines removal from wood room effluent. *Pulp and Paper Magazine of Canada*, 69(7):136-141, Apr. 5, 1968.

A pulp and paper mill in Cornwall, Ontario, has installed equipment which is currently removing up to 4.5 tons of bark fines per 8-hr shift from its wood-room effluent. The total cost of the stream improvement program was \$50,000. The screening system uses Centri-Cleaners to concentrate a 2,000-gal-per-minute flow from 0.2 to 2.0 percent o.d. consistency. The resulting slurry is dewatered on a single Kason vibrating screen to 15.0 percent o.d. consistency, before the solids are trucked away as waste. Measurements of sewer loadings, before and after the equipment was installed, show a 41 percent improvement over the untreated wood room effluent. Although the overall efficiency of the screening system may appear relatively low, the majority of the material requiring oxygen during decay is removed. Thus, BOD loading of wood from effluent has been reduced far more than suspended solids loading. Data collected from evaluation trials, as well as from current operations are presented with illustrated descriptions to provide a detailed view of the process.

68-0876

Whey concentration by reverse osmosis. *Food Engineering*, 40(3):124-127, Mar. 1968.

Disposal of cheese whey has become a critical problem. Cheddar cheese whey has been concentrated experimentally by a number of organizations using the reverse osmosis principle. This process is particularly advantageous for small plants, since they cannot afford conventional equipment. The whey can be concentrated with cheap reverse osmosis units, and then shipped to central plants for drying. In practice, reverse osmosis is accomplished by a semipermeable cellulose membrane, about one-third of a micron in thickness, backed by a porous support material which allows passage of the product water. Several types of support structure are now in use, and three units are briefly described. At present, cellulose acetate is the standard membrane material.

68-0877

Williams, R. H. They haul sludge on contract. *Compost Science*, 8(2):12, Autumn 1967-Winter 1968.

A Pennsylvania farm manager was contracted to haul and dispose of digested sewage liquid sludge from the

Chambersburg sewage disposal system. An oil tank was fitted to a truck for a total cost of \$800 for equipment. Very little odor and no handling is involved, as the truck driver heads into a field and pulls a cord at the cab that lifts the steel door covering the discharge hole. The liquid runs between 2 and 8 percent solids. Land to be used for radishes or tuber crops are avoided but corn ground, alfalfa fields, and sorghum-sudan plots are spread heavily. Although the liquid sludge cannot be spread evenly, the fertility effect is expected to build up over a number of years. The sewage hauling is also a means of fully employing farm labor.

68-0878

Willoughby, E. and V. D. Patton. Design of a modern meat-packing waste treatment plant. *Journal of the Water Pollution Control Federation*, 40(1):132-137, Jan. 1968.

A Florida meat processing concern has constructed a plant to treat the wastewater from the dispatching and processing of up to 350 head per day of cattle. The first attack on the problem consisted of reclaiming grease and cracklings from cooked viscera. The extended aeration modification of the activated sludge process was considered to have many advantages over other processes. The only lagoon permitted by State regulations and the geology of the area was a final stabilization or effluent-polishing pond. Total cost of the system was about \$250,000 or about \$20 per capita, based on the BOD population equivalent. Testing of composite samples over a 1 month period indicated that BOD averaged 95 percent, suspended solids removal averaged 84 percent, settleable solids removal averaged 98 percent, and grease removal averaged 98 percent.

68-0879

Woernle, R. Disposal of industrial wastes. *Chemie-Ingenieur-Technik*, 40(7):357-358, May 1968.

At the fourth meeting of the VTG/Dechema Association, held December 15, 1967, five papers were presented. The daily accumulation of waste in Wiesbaden, Germany, increased in the last few years from 1.15 liters to 3.37 liters per capita. The waste disposal site for the city could take the wastes of only 1 1/2 more years. The city decided in favor of crushing the wastes and dumping it into a sanitary landfill. By crushing, the volume could be reduced by 50 percent. Through the subsequent deposition, the volume is further reduced by 20 percent over the year. A brief description of the waste crusher, a hammermill, is given. The incinerator in Frankfurt am Main, West Germany, has four furnaces, each capable of burning 300 tons of waste daily and of producing 25 tons of steam (500 C, 59 atm). The slag is utilized. The causes for interruptions of the operation were leaky pipes near the grate, due to overheating of the material (now avoided by blowing in secondary air), and occasional clogging of the air preheater by ash deposits. The industrial waste incinerator of Fargenfabriken Bayer AG was built at a cost of 18 million DM. It has been designed to burn daily about 100 tons of solid, liquid, and viscous wastes. The three types are burnt separately. An incinerator for oil sludge and industrial waste in Munich is described. (Text in German)

68-0880

Work group 'Sludge Activating Methods' of the Waste Water Technological Association (ATV). *Gas und Wasserfach, Wasser, Abwasser*, 109(29):761, July 1968.

Meetings of the ATV work group concerned with sludge activating methods were held on April 27 and 28, 1967, in Prien, as well as on November 20 and 21, 1967, in Berlin, West Germany. In the 1965 report by the work group, general guide lines for the designing of sludge activating plants for various methods were given. Results of experimental and actual operations of the purification plants in the city of Stuttgart and in the Wupper Valley show the limits of such guide lines. In Stuttgart the BOD was reduced from an average of 200 mg per liter to 25 mg per liter within an aeration time of 1.5 hours (BOD per unit volume 3.0 kg per cu m and day, total sludge concentration 1 kg BOD per kg dry substance per day). To obtain the same result, the Wuppertal plant, which purifies municipal waste water together with waste water from a large chemical plant (mixing ratio 4 to 1), needs 9 hours of aeration in a two-stage biological plant (average BOD at the beginning of process 350 mg per liter BOD per unit volume 0.9 kg per cu m per day, total sludge concentration 0.3 kg per kg and day). The guide lines for primarily domestic waste water worked out by the ATV work group for a BOD of 25 mg per liter at the end of the process, called for a BOD per unit volume of 1.8 kg per cu m and day, and a total sludge concentration of 0.5 kg BOD per kg dry substance and day. This shows that guide lines are pertinent for domestic waste water, but when large amounts of industrial waste water are added, experiments are indispensable. At the meetings, moreover, such problems as sludge stabilization, the question of nitrification and denitrification with the aid of the sludge activating method, and the dimensioning of post-purification tanks were discussed. (Text in German)

68-0881

Work group ATV 'Sludge dehydration and disposal'. *Wasser und Abwasser*, 109(28):760, July 1968.

The work group 'Sludge dehydration and disposal' of the Waste Water Technological Association (ATV) held a meeting between April 20 and 22, 1967. New sludge activating methods were discussed, and new plants were visited in Switzerland. In the purification plant in Hamburg, tests were made to determine whether satisfactory drying of sewage sludge can be achieved with the flue gases from an incinerator, and to what water content the sludge must have been previously dehydrated. In a discussion on vacuum filtering, the importance of conditioning the sludge with the aid of chemicals was stressed. A report on improvements in the Lurgi sludge incineration plant in Stuttgart-Muehlhausen was given. In conclusion, an incinerator plant using the Passavant method was described. A thorough report on the present state of the art of sludge treatment will soon appear in the 'Handbook of Waste Water Technique', which will be published by W. Ernst and Son, Berlin. The 'Handbook on Waste Disposal', published by Erich Schmidt-Verlag, Berlin, also contains a summarizing paragraph on the 'Treatment and disposal of waste sludges.' (Text in German)

68-0882

Wright, C. D. Practice and control of activated sludge process treating combined industrial and domestic wastes. *Water and Sewage Works*, 115(1968):R139-R152, Nov. 29, 1968.

Revisions in methods of practice and control are necessary to permit continued use of the activated sludge process where

Hazardous Wastes

industrial waste is treated at a municipal sewage plant. Industrial wastes can be constant or seasonal. They may contain some form of nutrient deficiency which is detrimental to the sludge process such as low nitrogen, instability as related to a high rate of synthesis in the process, and low phosphorus. Requirements of the plant itself for operation of the activated sludge process include: varying air application rate in accordance with loading; assuring adequate oxygen transfer at high loading demand; and compensating for nutritional deficiency. The plant volume adjustment for seasonal loadings is best accomplished through use of plant units rather than a slack operation of the plant. The oxygenation rate as opposed to air application rate must be adjusted to comply with the loading. Volume indexes and loadings are considered, and the solution is application of measures to ensure compensation for nutritional deficiencies and unstable solids conditions. Operational practice and effective control require attention to such factors as control of return and waste activated sludge, solids handling and disposal, and analyses and records within the plant.

68-0883

Wulffinghoff, M., Translator. Disposal of process wastes: liquids, solids, gases. A Symposium presented at the AICHE Meeting, 1964, Frankfurt/Main, Germany, 1968. 240 p.

Along with chemical processes for detoxication and flocculation, biological treatments for decomposing organic impurities in effluents have proved most effective in dealing with the waste water problems of paper, cellulose, tannery, glue, and textile industries. A survey is presented of the ion-exchange processes and the use of an Infrared Spectrophotometer. Effluents containing radioactive contaminants, which can be treated by various decontamination processes, are discussed. Biological treatment of solid waste from communities and industry, composting of organic waste material, the advantages and disadvantages of various types of apparatus used for the recovery of proteins from sewage effluents, ionized solutions, waste water from the preparation of potato flour, and the requirements for practical economic encapsulation systems for the long term permanent storage of high level nuclear wastes are discussed. The purpose of afterburning involved in combustion of industrial processes, the Bayer 'double-contact' process, and the development work aimed at the removal of sulfur dioxide from exit gases are considered in detail. A bibliography, glossary, and index are included.

68-0884

Young, E. F. Water treatment plant sludge disposal practices in the United Kingdom. *Journal of the American Water Works Association*, 60(6):717-732, June 1968.

The most widely practiced stage in water treatment in the United Kingdom is the chemical coagulation of surface waters with either aluminum or iron salts, resulting in hydroxide precipitates. This gelatinous hydroxide sludge presents a problem in controlling the rate at which water is drawn from the sludge. Chemical treatment of hydroxide sludges is becoming more widely practiced, the sludge being dosed with lime or polyelectrolyte. Cold lime-softening is frequently practiced, which involves the addition of lime, and

sometimes soda ash, to produce a precipitate containing a considerable volume of solid particles. Sludge processing involves successive stages of water separation from the sludge, and an alternative process in each stage is shown. Thickening tanks are the self-cleaning type, and the type relying upon mechanical scraping of the sludge to a convenient point. Filter presses have been used with varying results. The centrifuging of lime-softening sludges is likely to become more popular. The Water Research Association concluded that the dewatering characteristics of lime-softening sludges can be controlled by the method of softening, but that there is less control over the properties of hydroxide sludges. The Fylde Water Board concludes that the variations in a particular sludge are not insignificant, that temperature variations change sludge characteristics profoundly, and that thickened sludge should not be pumped too quickly or for too long. The operations of various treatment plants are discussed.

68-0885

Zievers, J. F., R. W. Crain, and F. G. Barclay. Waste treatment in metal finishing: U.S. and European practices. *Plating*, 55(11):1,171-1,179, Nov. 1968.

Waste laws, acceptable discharge tolerance levels to watercourses, and metal finishing waste treatment methods are summarized for the United States and selected European countries. The cost involved in meeting various waste treatment requirements is shown graphically. The results of a survey are included for 15 cooperating plants located throughout the country with different degrees of metal finishing waste treatment, varying flow rate, and raw water costs. The trend found in the survey definitely is toward more stringent enforcement in the area of suspended solids to streams. Because of the low tolerable limits for suspended solids acceptable to government authorities, pressure filtration seems to be the best or only answer. Conventional and 'package' plants are compared and illustrated. The trend seems to be toward effluent treatment plants in which 60 to 80 percent of the water taken into a metal finishing operation can be reused.

HAZARDOUS WASTES

68-0886

Active rubbish dump. *Nature*, 219(5159):1,098, Sept. 14, 1968.

Although the bulk of radioactive waste from nuclear reactors is small, it is dangerous. The U.S. Atomic Energy Commission and the National Academy of Sciences have announced a joint committee to investigate procedures for waste disposal. Last year, the European Nuclear Energy Agency organized a joint operation in which radioactive waste from Belgium, France, West Germany, the Netherlands, and Great Britain was dumped in the North Atlantic. The waste was put in containers and delivered to convenient ports, where a chartered ship picked it up and carried it into the northeast Atlantic and dumped it overboard. Disposal of this waste on the bed of the Atlantic at the rate of 1,000 curies per year results in intakes of radioactivity which are many orders of magnitude below those recommended by the International Commission on Radiological Protection. Most of the wastes were beta/gamma wastes, which have fairly short half-lives.

68-0887

Armstrong, D. H. Airborne pathogens associated with solid wastes handling. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint C-10.)

Municipal refuse handling operations constitute a health hazard, since the dust generated carries a large number of microorganisms, including pathogens of intestinal and respiratory tract origin. The degree of hazard depends on the concentrations of the dust and the types of organisms associated with the dust. A qualitative and quantitative study was made by the Solid Wastes Program of the microbiological flora of the dust associated with four municipal refuse incinerators and a composting plant. Air samples were taken with an Anderson volumetric sampler used in conjunction with TSA blood agar and eosin methylene blue agar plates. The results, as reflected by the isolation of pathogens, indicate that the potential health hazard from the dust is significant.

68-0888

Bernard, H. Radioactive waste management. In Industrial waste disposal. New York, Reinhold Book Corporation, 1968. p.274-312.

Since the nuclear industry must meet standards of ultrahigh quality in its effluent streams, various processes and components are used as intensively as possible. The generally approved effluent standards are considered. The types of waste, whether from mining and milling, feed materials and fuel fabrication, production, power reactor wastes, laboratories, or chemical separation processes are examined. Treatment of radioactive wastes can be considered in three parts: low activity wastes, intermediate activity wastes, and high activity wastes. Disposal of high activity wastes is always by containment as liquids or by immobilization and storage as solids. Perpetual containment is the only method deemed possible for these wastes due to the hazards involved. Research to reduce all of these wastes to solid form, thus reducing the hazards of trying to store liquids which may leak, is described. Various disposal methods for other types of wastes are considered. Diagrams, data, and illustrations as well as an extensive list of references are included. The waste stream diagrams for the various AEC sites are given.

68-0889

Disposables are dangerous. Pennsylvania Medicine, 71(3):49, Mar. 1968.

Used syringes, needles, and drug samples present disposal problems: children can get them and use them as toys and others can injure themselves. The problem of drug dependence and addiction should not be compounded by improper disposal of medical supplies. Dangerous substances should be kept out of the trash can. A machine is available from surgical supply houses which will destroy a disposable needle. Another machine will crush a syringe. There are many other methods for proper disposal. If the institution is large enough to maintain an incinerator, all these items can be burned. A jar of commercial acetone can be kept on hand, and the syringe (or half of it) disposed of by dropping it in the jar. Needles can be 'defused' with an inexpensive wire cutter.

68-0890

Floyd, E. P., and A. W. Breidenbach. Preliminary estimate of the significance of pesticide residues in solid wastes and problems of reduction or elimination of these residues. Presented at 156th National Meeting, American Chemical Society, Atlantic City, Sept. 8-13, 1968. 6 p.

Chief contributors to pesticide wastes are industrial and agricultural operations, commercial pest control operations, and individual homemakers and gardeners. In municipal refuse, a major part of chemical pesticide wastes are found in the discarded pesticide containers, including the spent aerosol cans. Primary reasons for the concern of the Solid Wastes Program with pesticide residues are as follows: possible occupational hazards; threats to the normal biota of the environment; adverse effects on microbiological processes occurring within composting material or sanitary landfills; adverse effect on the utilization of solid wastes such as food processing wastes; contamination of the environment through leaching by groundwater or surface water or through stack emissions of incinerators. One of the combustion products of chlorinated hydrocarbons is hydrogen chloride, which is toxic and corrosive. Current research efforts in determining the sources, uses and fate of pesticides are discussed. Disposal techniques for solid pesticide residues fall into 2 basic processes: to detoxify the waste pesticide by degradation or decomposition; to concentrate and contain the toxic material in a safe location. Current techniques considered practical for pesticide disposal are: rapid decomposition by use of heat as in incinerators, fluidized beds, and by chemicals; natural decomposition by soil microorganisms, air, and sunlight; burial using steel drums; pumping into deep wells. The ideal method for disposal is by conversion into useful products.

68-0891

Gray, K. R. Toxic element hazards in municipal compost. Public Cleansing, 58(7):331-334, July 1968.

The aim of the Haughley research project is to investigate the toxic elements which are frequently present in municipal compost to determine if these are absorbed in sufficient enough quantity by crops to cause danger to humans. Municipal authorities must face the problem of disposing of about 10 million tons of municipal refuse and sewage sludge each year, and the use of composting as an acceptable method is hindered if toxic elements are present in the finished product. Although much metal is removed by magnetic separators or screens during composting, small metal objects and metal salts which form chelates remain. Although vital to life in small quantities, trace metals can be toxic in large amounts. The author was asked by the Soil Association to form a committee and institute field trials to investigate the toxicity of compost. Six fields will be treated, five of which will be given a light application of nitrogen, phosphorus, and potassium. Each of the six will be divided into four plots, and each year 96 vegetable samples will be analyzed for about 12 elements, and in addition the composts and the soils will be examined. The elements currently being investigated are: As, B, Be, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Se, V, and Zn. When the results become available, additional assistance will be obtained through the British Industrial Biological Research Association. The Small Animal Feeding Project will also determine toxicity.

Packaging Wastes

68-0892

Johnson, H. Selenium in solid waste. In Engineering Foundation Research Conference, Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint C-11.)

Since approximately 70 percent of the 800 million lb of solid waste produced per day in the United States is paper, and since selenium is known to be present in almost all conceivable types of paper, environmental exposure of selenium is increasing through solid waste handling and disposal. The fact that selenium and its compounds are quite toxic prompted an investigation by the Solid Wastes Program of selenium concentrations in solid waste. A fluorometric method for the detection and quantification of selenium was used. Newspaper, cardboard, and compost materials were analyzed to establish dormant or potential levels of selenium, and finished compost, incinerator residues, quench water, stack samples, and air samples, both near to and distant from incinerator sites, were analyzed to show the effects of the particular disposal method.

68-0893

Sax, N. I. Dangerous properties of industrial material. 3d ed. New York, Van Nostrand Reinhold Company, 1968. 1251 p.

The purpose of this work is to provide a single source for quick, up-to-date, concise, information about more than 12,000 common industrial and laboratory materials. In recognition of the great level of public interest now focused upon exploitation of the environment to the detriment of public health, a section on air and water pollution problems, and the burgeoning problem of solid waste disposal has been included.

68-0894

State task force develops plan for safe disposal of chemical wastes. Public Health News, 49(7): 132, 134, July 1968.

A special advisory task force, appointed by State Health Commissioner Roscoe P. Kandle, (N.J.), is expected to produce a set of regulations that should prevent serious accidents from occurring in the disposal of chemical wastes. Some rules have already been agreed upon and are currently in effect for a nine-month trial period. The task force plan calls for a uniform system for classification or coding of waste chemicals which will identify type and degree of hazard (health, flammability, reactivity, and noxious odor), and identify those that are non-hazardous. Also incorporated in the plan is a system of classification of receiver facilities to give specialized services, including the handling and treatment of various hazardous waste products. Because of the legal responsibility chemical shippers will provide, under the plan, minimum labels in accordance with the current ICC regulations for 'Explosives and Other Dangerous Articles.' The plan also calls for the shipper to provide a bill of lading to accompany each shipment of waste chemicals. The State Department of Health is expected to promote the new labeling and handling system, and to establish an information center for disposal of chemical wastes.

PACKAGING WASTES

68-0895

Abrahams, J. H., Jr., and R. L. Cheney. The role of glass containers in solid waste disposal. New York, Glass Container Manufacturers Institute, Inc., Oct. 8, 1968. 8 p.

Glass can be considered a universal packaging material, since it is made from the most abundant raw materials and, during proper disposal, can be readily reduced to small particles and returned to the soil in its original state. Glass can also be melted for use in the manufacture of new containers or as raw material for other industries. Since it is inert, glass will not leach, rust, rot, mold, putrefy, decompose, or cause disease or noxious gases. Glass has been shown to be of little or no problem in disposal. In a landfill, glass fragments will not contribute to settling problems; in incineration, glass fragments aid in aeration, do not produce gases, and can be reclaimed. In composting, ground glass acts as a soil conditioner if not reclaimed. The glass industry is actively researching improvement in its products, and in ways and means of facilitating the recycling of waste glass into productive uses.

68-0896

Darnay, A., and W. F. Franklin. The role of packaging in solid waste management, 1966 to 1976. Statement before the U.S. House of Representatives Subcommittee on Science, Research, and Development, 90th Cong., 2d Sess., Feb. 2, 1968.

The conclusions of a study initiated at the Midwest Research Institute, under contract to the Public Health Service, Solid Wastes Program, to develop definitions of the role packaging plays in solid waste, were stated before the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics of the U.S. House of Representatives. The aims of packaging and of solid waste disposal are mutually exclusive, on the whole. The large quantity of packaging wastes imposes a general load on the disposal facilities of the nation. The consumption of packaging materials for 1966 and 1967 is tabulated. Collection of packaging materials is costly if containers are thrown away carelessly, easy if they are discarded in waste cans. Processing of packaging wastes may be easy or difficult depending upon whether they are dumped, incinerated, or used in landfills. In landfill operations, the greatest single difficulty presented by packaging materials is the resistance to degradation in the soil of certain materials such as aluminum, glass, and plastic. In incinerators, metals and glass show up as inert residue which must be hauled away. Ideally, packaging materials should not be discarded but reprocessed by industry and made into new packages or other products. Each ton of recycled wastepaper saves 17 pulp trees. Future research needs include: automation of waste collection; separation of refuse into its components; refinement of heterogeneous waste masses; development of secondary uses for wastes; and improvement of salvage operations.

65-0897

Fulmer, M. E., and R. F. Testin. Report on the role of plastics in solid waste. New York, Society of the Plastics Industry, [1968]. 31 p.

The Society of the Plastics Industry requested the Battelle Memorial Institute to investigate the effects of plastics on refuse disposal systems. The percentage of plastics in refuse is 1.5 percent, but it is expected to more than double during the next decade. In sanitary landfilling and composting, plastics are not considered a significant problem. In open dumping, if accompanied by uncontrolled burning, plastics can contribute to problems of smoke and odor. The major, future-problem area associated with increased use of plastics is expected to be connected with disposal by incineration. Plastics contribute 0.322 percent of the total noncombustibles or 2 lb per ton of refuse. Estimates based on the total quantity of polyvinyl chloride plastics believed to enter municipal refuse suggest that incinerator stack concentration of HCl from this source may approach toxicological limits. There is a need for more detailed reporting systems for all categories of materials, and for a relatively detailed economic analysis of the future growth of plastics in solid wastes. Attention should be focused on potential problems connected with incineration of refuse, with particular emphasis on the generation of hydrogen halides, the release of smoke, economic separation of plastics, and grinding and shredding of combustibles. Appended data cover: present consumption and future usage of plastic bottles, government activity in solid waste, and fire hazards peculiar to the use of plastics.

65-0898

Fulmer, M. E., and R. F. Testin. Introduction. Summary. Problems caused by plastics in solid waste. In Report on the role of plastics in solid waste. New York, Society of the Plastics Industry, [1968]. p.1-3.

A study of available records on solid-waste disposal in the United States uncovered no quantitative evidence of problems uniquely assignable to the presence of plastics. The percentage of plastics in municipal refuse is 1.5 percent, but is expected to more than double during the next decade. Problems caused by plastics in solid wastes include: clogging of incinerators due to melting; production of black smoke when burned at low temperatures; corrosion of equipment by gaseous products of combustion; production of physiologically undesirable combustion products; and generation of offensive odors when burned at low temperatures. In sanitary landfills, plastics may produce a slight decrease in density, but are not considered a source of pollution. In composting, plastics may affect the appearance of the end product, but are not expected to affect its properties in any other way.

65-0899

Fulmer, M. E., and R. F. Testin. Current and future role of plastics in solid waste. In Report on the role of plastics in solid waste. New York, Society of the Plastics Industry, [1968]. p.3-7.

As an aid to evaluating the present and future roles of plastics in solid waste, forecasts of plastics-packaging usage were

made at three levels to represent 'low,' 'high,' and 'best' estimates. A large spread between the 'high' and 'best' (or most realistic) estimates reflects the degree of uncertainty concerning the future use of plastics—particularly plastic bottles. The probable major constituents of plastic are: polyethylene (38%), polyvinyl chloride (32%), and polystyrene (21%). The total amount of plastic waste disposed of in refuse currently is 3½ billion lb per year or about 1.5 percent of the total amount of refuse generated. It has been predicted that the total volume of packaging will increase by 50 percent in the next 10 years, and that the plastics portion will double from 1 to 2 percent in that period. The best estimate of plastic-milk-bottle penetration by 1976 is 50 percent of the gallon and half-gallon containers. This represents a total potential volume increase of 0.37 billion cu ft per year. This potential volume increase does not appear to be significant since some compaction of plastic bottles will occur. A recent FDA regulation regarding use of a PVC-PE copolymer for food-contact applications indicates that the fraction of PVC in packaging will probably increase.

65-0900

Fulmer, M. E., and R. F. Testin. Current and future disposal practices. In Report on the role of plastics in solid waste. New York, Society of the Plastics Industry, [1968]. p.7-12.

Two methods of reducing refuse quantities are through improved household incinerators, or shredding and grinding all combustibles such as paper and plastics, to a size suitable for disposal in the sewage system. Whatever is done to impart fire resistance to plastic materials will also make the material more difficult to incinerate. If a comparatively large stratified mass of plastics enters an incinerator, the mass softens and then melts and flows, causing difficulties in grate-type incinerators. Smoke and soot from plastics which escape the primary combustion zone are also problems. The presence of halogens in plastics inhibits combustion, causes corrosion of the metals of the incinerator, and contributes to air pollution. Plastics in landfills are not considered to contribute to air and water pollution, although some difficulty is experienced in compressing rigid containers. Plastics have been known to pass through composting systems without being thoroughly disintegrated. The pollution caused by burning plastics in open dumps is indistinguishable from the pollution produced by many other components of refuse. The concentration of HCl produced at street level from emissions of burning refuse containing 0.15 percent chlorine would be about 0.005 ppm. If gases such as HCl, HF, sulfur dioxide, and oxides of nitrogen are not removed from household incinerators or are handled in units which are not well vented, the burning of PVC (polyvinyl chloride) may constitute a toxic hazard.

65-0901

Fulmer, M. E., and R. F. Testin. The relative importance of plastics in planning for refuse disposal. In Report on the role of plastics in solid waste. New York, Society of the Plastics Industry, [1968]. p.12-15.

Three of the most important characteristics of refuse to be considered in planning a disposal system are: percent

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noncombustibles and heating value, polluting effects on air, water, and land, and smoke properties. Plastics contribute 0.322 percent of the total noncombustibles or 2 lb per ton of refuse. The total heating value of refuse on a dry basis averages 6200 Btu per lb, of which 2.3 percent is contributed by plastics. Plastics do not appear to have any potential as land or water pollutants. Gaseous emissions and smoke from burning plastics will contaminate the atmosphere if not controlled. HCl is either not present in detectable amounts or not measured in the emissions from refuse disposal processes. The total pounds of chlorinated plastics produced in 1965 (1.837 billion), multiplied by the average weight percent evolved as HCl (35%), gives the total amount of HCl pollution from this source (0.63 billion lb). The concentration of HCl in the air of various cities has been found to vary between 0.10 and 0.58 ppm. There are some standards limiting discharges of HCl and chlorine in Great Britain and Germany, but at present there is no indication when HCl criteria might be considered in the United States. The smoke from polymethyl methacrylate is less dense than from burning red oak wood. Polyvinyl chloride and polystyrene plastics produce dense black smoke as do many plastics which contain additives to make them self-extinguishing. The obvious method of removing smoke discharges is to completely oxidize all the materials in the smoke.

68-0902

Fulmer, M. E., and R. F. Testin. Utilization of plastic materials in municipal refuse. In *Role of plastics in solid waste*. New York, Society of the Plastics Industry, [May 1968], p.15-16.

The only use that is made of plastic materials in refuse at the present time is for recovery of their heating value, but there is a reuse for thermoplastics in plastic manufacturing processes. The principal difficulty facing reuse of plastics in municipal refuse is the problem of separating the thermoplastics from the other constituents of refuse. The cost of hand sorting is prohibitive in the United States, and no methods of machine separation are described in the literature. At present, the only remotely feasible system appears to be sorting at the source, i.e., by the householder. Thermosets, even if isolated from the rest of the refuse, cannot generally be reused in plastics manufacture. The proportion of thermosets in waste plastics in refuse is extremely small—on the order of 5 percent—and even this proportion appears to be decreasing.

68-0903

GCMF aide proposes plan for salvage, reuse of waste glass. *American Glass Review*, 89(3): 28, Sept. 1968.

The Glass Container Manufacturers Institute is proposing a plan to develop markets for discarded bottles and jars. The first objective is to salvage waste glass for reuse as cullet in the production of new glass. Next is the development of secondary uses for waste glass, as in the manufacture of decorations, specialty paints, insulation and building materials. The third goal is to facilitate the inclusion of glass in normal waste disposal processes. A system of regional 'transfer stations' to which household garbage and refuse would be carted for salvage and reuse, was also proposed. The

refuse would initially be transported in ordinary garbage trucks to automated transfer stations, which would be equipped to separate the material into its various salvageable components.

68-0904

Growth trends in containers and packaging, 1954-66. *Containers and Packaging*, 21(1):6-9, Apr. 1968.

Packaging volumes soared 9.4 percent to \$16.8 billion in 1966, and dollar volume was 94.4 percent above the 1954 total. Textile and wood containers' growth is partly attributable to the Vietnam conflict. Glass containers dropped from 7.8 to 7 percent of total packaging sales. Metal containers also dropped in number, while paper containers gained relatively. Plastic containers rose from a 7.4 percent share in 1958 to a 10.2 percent one in 1966. Data is given on the value of shipments of containers and packaging materials, annual wholesale price indices, conversion of aluminum foil, and shipments of plastic products.

68-0905

Jany, V. Experience with disposable blankets and sheets in the Auguste-Viktoria Hospital in Bad Lippspringe. *Staedtehygiene*, 19(8): 173-174, Aug. 1968.

The Auguste Viktoria Hospital treats patients with respiratory diseases (tuberculosis). It has a capacity for about 300 male and female patients who remain in the hospital for 6 months and more. The disposable blankets, which were introduced a short while ago, proved to be an enormous success. They have a life expectancy of about 12 weeks. They come in sealed plastic bags. The used blankets go to the hospital incinerator. No dry cleaning of woolen blankets and no disinfection is required. The blankets are made of a soft plastic fiber which warms just like a feather bed. Disposable towels have long been in use, but a switch to single-use towels is recommended. Disposable sheets and pillows are on the market, but their use remains limited to special cases. However, a breakthrough in this is imminent. (Text in German)

68-0906

Klatt, M. When will the PVC beer bottle come? *Verpackungs-Rundschau*, 19(6):681-628, June 1968.

A plastic beer bottle must satisfy numerous requirements including good impact strength and high fatigue limit. These and others can be met at present only by a PVC (polyvinyl chloride) type plastic of special formulation, such as SOLVIC-PREMIUM PEB 911/5705 (Deutsche Solvay-Werke GmbH, Duesseldorf, Germany). A plastic beer bottle of the latest design weighs only 29 g, 30 percent less than a non-returnable glass beer bottle. The material for the plastic bottle costs 5.5 Pfennig. The handling of returned glass beer bottles costs 2.6 to 7.0 Pfennig per bottle. As to the problem of solid waste posed by non-returnable plastic beer bottles, the share of all plastics in the total quantity of refuse amounts to only 0.2 percent. If it is assumed, optimistically, that the share of beer packaged in PVC bottles will increase to 5 percent within the next few years, a rough calculation shows that the quantity of PVC bottles in the total refuse would amount to only about 0.1 percent. This amount would

not pose any danger to refuse incineration equipment, nor will it entail an air pollution problem. (Text in German)

68-0907

Last word on disposable bottles. *New Scientist*, 39(614):532, Sept. 12, 1968.

In the United States, it has been estimated that 48 billion aluminum cans, 28 billion jars and bottles, and myriads of plastic containers are discarded each year. Non-returnable bottles and cans are swelling the output of solid waste. Dr. Samuel Hulbert of Clemson University, South Carolina, has been given a grant by the U.S. government to develop his invention of a bottle that disposes of itself after discard, by turning into water. It is constructed of material which will react with water in the atmosphere to dissolve in a few days into a pool of water.

68-0908

Mukhopadhyay, B., and D. G. Wilson. Appendix H. Glass systems. In *Summer study on the management of solid wastes: final report*. v.1. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. p.46-54.

The apparent economic and social costs of the older method of handling returnable glass containers to the retailers for a refundable deposit are compared to the system in which bottles are thrown away. There are many difficulties in the way of finding the true costs. It is usually cheaper to buy beverages in returnable bottles even if they are not returned, than to purchase 'one way' bottled drinks. A proposed machine to be placed at supermarkets will accept all sorts of glass containers, refund a sum depending on the usefulness of the bottle, sort some bottles for return to local bottlers, grind the remaining bottles into cullet sorted by color, and sell back to the glass producers. A hypothetical case with supporting cost data on the development of the machine, the number of bottles handled per year, and average net profit for the use of the machine less costs of collection and disposal by the municipalities without such a machine is presented. A revised assumption and calculations section supplement is included in the appendix.

68-0909

Onasch, H. Is the introduction of no-return plastic bottles advisable? An evaluation from the viewpoint of a municipal city cleansing department. *Staedtehygiene*, 19(10):228-231, Oct. 1968.

No-return plastic bottles are being used increasingly as, for instance, in the brewery industry. A total switch of this industry to these bottles would mean that a city like Hamburg must reckon with 300 million bottles to be disposed of. For this purpose the city would need 58,000 new waste containers, 23 additional waste collecting trucks, and 140 more employees. The investment costs would amount to about 5.4 million DM, the annual operating costs to 2.8 million DM. The necessary investment costs are about 2.5 times higher than the annually available fiscal means set aside for new purchases. Each no-return bottle would cost the city cleansing department 0.93 Pfennig annual operating costs and 1.80 Pfennig investment costs. A second problem

of this sort is with plastic milk bottles. In case of a switch to these bottles, the municipal city cleansing department of Hamburg would need 43,000 additional waste containers, 16 new waste collecting trucks, and 98 more employees. The additional operation costs arising through these innovations would have to be carried by the citizens. To the average family with two children, the introduction of both the plastic beer bottle and the plastic milk container would mean an annual additional charge of about 11 DM; in some cities it might even be higher. But the much greater problem lies with the individual city cleansing departments which lack the means for the additional investment costs. (Text in German)

68-0910

Plastic milk containers. *Public Cleansing*, 58(2):50-51, Feb. 1968.

The North Staffordshire Co-operative Dairy is now supplying a limited number of about 1,000 plastic milk bottles a day to schools in Stoke-on-Trent. The dairy is collecting the discarded receptacles and returning them to the depot, where they are passed through an amacerator which shreds the plastic into strips a quarter of an inch wide, the resultant material being stored in a 12 cu yd container ready for collection by the local authority. The use of plastic receptacles for larger containers has distinct advantages over glass, both in terms of weight and volume. It is estimated that 16 quart containers would occupy approximately 1 cu ft or more in the dustbin.

68-0911

Plastics pose a solid waste disposal problem. *Environmental Science & Technology*, 2(2):80, Feb. 1968.

The disposal of plastics by incineration does not seriously affect the overall solid waste disposal operation at present, since only 3.25 billion lb, or 1.5 percent of the solid waste material is plastics, according to estimates of the Battelle Memorial Institute study for the Society of Plastics Industry, Inc. This percentage may, however, double in the next decade and, should existing incineration practices continue in place of composting and sanitary landfill operations, the disposal of plastics could create air pollution problems, particularly from hydrogen chloride and other hydrogen halides. Polyvinyl chloride, which constitutes one third of all plastics, is the worst offending pollutant. The Public Health Service has no plans to develop air quality criteria for hydrogen chloride, although its concentrations in incinerator stacks may approach toxicological limits under certain conditions.

68-0912

Role of packaging in waste disposal explained. *Clean Air News*, 2(5):6-8, Feb. 20, 1968.

A study was made by the Midwest Research Institute for the Solid Wastes Program of the Public Health Service to analyze the kinds and amounts of packaging materials being used today, and to determine possible packaging trends. Of the 46 million tons of packaging materials sold in 1966, nearly all was discarded as rubbish accounting for 12 percent of the 350 tons of solid waste generated in the United States. Major

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findings of the study were: the aims of packaging and solid waste disposal are mutually exclusive; paper accounts for more than half of all packaging materials; although plastics will double in tonnage, they will amount to only 1/14 of the paper used in 1976; of the 45 million tons of packaging materials produced in 1966, only about 4.5 million tons were recovered; in 1976 only three out of 100 beverage containers will be returnable. Equipment that separates materials automatically and new techniques of pelletizing, shearing, baling, compressing and sorting scrap are needed. Manufacturers can ease the load on waste disposal operations by modifying the composition of packaging materials so that they become suitable for recycling.

68-0913

The self-destroying beer bottle. *New Scientist*, 39(605):63, July 11, 1968.

An answer to the unsightly non-returnable beer bottles which mar tourist beauty spots is the disappearing or self-destroying bottle. Rigello Pak AB, a branch of a Swedish paper carton company, has produced a cylindrical container with a cone-shaped top. The container is made of rigid PVC, Saran, and a paper sleeve lined with thin aluminum foil, and plastic glue. It weighs 20 g compared with 200 g for its glass counterpart. The manufacturers claim it can withstand the pressures of storage and transport. When it is thrown away, the paper disintegrates and rots. The plastic is decomposed by sunlight and acids in the soil, and can also be burned. Another 'self-destroying' bottle was produced in Germany two months ago.

68-0914

Seymour, W. N. 80,000,000 bottles a day. *Compost Science*, 9(2):18-21, Summer 1968.

The problem of disposing of the ever increasing amounts of waste, including an estimated 28,200,000 gross soft drink bottles of the 'no deposit, no return' type, becomes more difficult each year. The prospect of an almost unbreakable glass bottle in the near future will further aggravate this problem. From the standpoint of citizens concerned about the preservation of natural beauty, the principal focus is on cans, bottles, 'pop tops,' and new plastic devices. It is estimated by Michigan highway officials that it costs \$2,500 per mi to pick up litter during the course of a year, or 32 cents for each piece of litter. Public relations campaign have no more than put a dent into the overall problem of litter. Establishment of a 'disposal fee,' to be applied at the manufacturer's level for each container produced, and which would be reimbursed to him for each container returned to him for salvage, is proposed. A 'conservation patrol' composed of unemployed youths as seasonal personnel for the cleaning of parks, beaches, historic sites, etc., to be paid for in part by the proposed disposal fee and the establishment of a 'Technology and Reclamation Council' to handle the ultimate disposition of solid waste, are also suggested. The rapidly deteriorating salvage industry would seem to require government aid to facilitate the disposal of junked autos, and to operate any serious salvage operation for refuse.

68-0915

Stapler, J. T., W. J. Barnes, and W. E. C. Yelland. Thermal degradation of polyvinylidene fluoride and polyvinyl fluoride by oven pyrolysis. Technical Report 69-7-CM, Natick, Mass., U.S. Army Natick Laboratories, July 1968. 37 p. (Distributed by National Technical Information Service, Springfield, Va., as Publication No. AD 672 509.)

During pyrolysis, both PVF sub 2 and PVF yielded hydrogen fluoride, complex mixtures of other volatile products, and residual char. The main differences were in the nature of the volatile products and the amounts of char formed. The volatile products from PVF sub 2 consisted largely of highly fluorinated, nonflammable materials; those from PVF contained much less fluorine and were flammable. The amount of char formed from PVF sub 2 was approximately twice as great as that formed from PVF. Although the amounts of hydrogen fluoride yielded by each polymer were large, differences between them were small, and not considered significant. It is inferred that the greater ability of PVF sub 2 to attenuate energy from high-intensity thermal sources, as compared to that of PVF, may be attributed in part to its ability to produce nonflammable smoke. This would tend to scatter the radiant thermal energy and keep it from reaching the polymer surface, whereas the smoke from PVF would ignite and thus create an additional heat source.

68-0916

Taeuber, F. The no-return bottle and its disposal. *Staedtehygiene*, 19(10):231-232, Oct. 1968.

Back in 1959, Sweden introduced the no-return bottle and since then its use has been increasing everywhere. It is estimated that about 2 billion no-return bottles, mostly plastic, will be thrown away in 1970. The glass bottles are also being thrown away in increasing amount. In the city of West Berlin, the per capita accumulation of plastic waste material, such as bottles and containers, was 0.58 kg (1956), i.e. about 0.2 percent of the waste accumulation. With the plastic no-return bottles, waste incineration and dumping become more difficult. More trouble with corrosion will be encountered. The plastic bottles are voluminous and cannot be crushed as easily as glass bottles. The no-return beer bottle made of PVC forms hydrochloric acid when it is incinerated. Moreover, these bottles do not rot easily. To ameliorate the problem somewhat, Farbwerke Hoechst introduced a crusher for these bottles. The machine is capable of crushing 750 bottles down to a volume which fills a 110 liter container. The container could be transported off with the rest of the wastes. Dumping is made simpler that way. The crushed plastic pieces can be also mixed among the tar used for paving streets. (Text in German)

68-0917

Vaughan, R. D. Packaging and solid waste management. Presented at 30th Annual National Packaging Forum of the Packaging Institute, New York, Oct. 7-9, 1968. 11 p.

About 90 percent of the approximately 51.7 million tons of packaging materials produced and sold in the United States in 1966 entered the solid waste streams, accounting for about

13 percent of the 350 million tons of residential, commercial, and industrial rubbish that were generated that year. By 1976, it is estimated that consumption of packaging materials will have increased to 73.5 million tons. Several surveys have tended to confirm the strong packaging/litter relationship. The reasons for the increase in packaging wastes include: the rise in self-service merchandising; the convenience and customer acceptance of nonreturnable containers; and the much greater choices in materials now given the packaging designer with the availability of plastics and other new materials. The Solid Wastes Program has sponsored a number of projects relating to the problems caused by packaging wastes: an evaluation of a fermentation method for converting waste paper to a protein supplement for livestock feed; a survey and literature search of such areas as plastic reclamation and disposal and properties of plastics and resins; development of a one-way container made basically of a water-soluble glass that, when emptied, may be dissolved; and a comprehensive study of the role of packaging in solid waste. More research should be undertaken to develop disposability properties of packaging materials and enhance their value as salvage. Particular emphasis should be placed on litter control campaigns. Governmental action may reduce the packaging disposal problems through the use of incentives and taxes. The packaging industry itself can devote more research effort toward finding more efficient and economic ways of disposing of packaging materials.

68-0918

The waste-high crisis. *Modern Packaging*, 41(11):102-107, Nov. 1968.

Traditional methods of refuse handling are being bogged down in the morass of empty containers, which are becoming increasingly difficult to dispose of. Public officials are looking for packages which are degradable or easier to dispose of. The major goal, however, remains packages which can be recycled to preserve natural resources. Packages are getting more durable, and per-capita consumption of packages is growing much faster than population. Self-destructing packages are definitely in the future, including plastic bottles and metal cans. Water soluble packaging material is also a real possibility. Recycling of wastes is viewed as the ultimate answer to the problem, either through use of the heat value of solid waste or through reuse of the packaging material itself. Government regulation is envisaged if packagers and suppliers do not work to help alleviate the litter and solid wastes problem.

RECYCLING

68-0919

Aluminum recovery system will pay dividends. *Materials Reclamation Weekly*, 113(10):27, Sept. 7, 1968.

General Dynamics Convair division could recover as much as 1.5 million dollars over the next 5 years by having the aluminum scrap metal from their milling operations converted into ingots for resale. The metal will be picked up in loose condition, transported to a Los Angeles smelting company, and converted to assayed 20 to 50 lb ingots. Over

22 million lb of aluminum scrap metal are expected to result in the next 5 years.

68-0920

Anderson, J. W., and G. H. Atherton. Economics of producing wax from Douglas fir bark from the study disposal of wood and bark wastes by incineration or alternative means. Corvallis, Oregon State University, School of Forestry Research Laboratory, Oct. 1968. 25 p.

Economic and technical analysis was found to favor extracting wax from Douglas fir bark. Based on a total wax production of 9,200,000 lb per year, which is about 2.8 percent of estimated total competitive U.S. wax consumption, and a capital investment of about \$2 million, the return on investment was nearly 19 percent, with a payout time of 3½ years. Increase in raw material (bark) cost by 75 percent, increase in capital investment by 25 percent, or decrease in balsam wax price by 50 percent, did not affect profitability seriously. Operation of the plant at 60 percent capacity, or reduction of plant size by 50 percent, reduced profitability the most, emphasizing the importance of full operation and optimum plant size. On the basis of the above factors, return on investment varied from a low of about 7 percent to a high of about 26 percent with payout times of about 6 and 3 years, respectively. It is recommended that a technical and economic analysis should be made of a complete chemicals-from-bark operation, where the extracted bark also is utilized as fuel, building board, charcoal, or mulch. Included in the appendices are economic summary calculation sheets, and the bases for the economic summary, manufacturing cost estimate, and capital investment. (Work performed under contract to the Public Health Service)

68-0921

Animals take to oil waste food. *New Scientist*, 40(626):544, Dec. 5, 1968.

At a conference in Amsterdam organized by the Dutch Society for Nutrition and Food Technology, Dr. C. Shacklady from the Research and Technical Development Department of British Petroleum Ltd. described preliminary results of a trial with gas-oil grown yeast. Results show that in food value, safety, and palatability, this type of yeast presents an efficient alternative to high-protein fish meal and soy bean meal in pig and poultry feeds, provided that extra methionine is added. Brief experiments were also run to discover whether animals actually like eating yeast food supplements, and whether meat from animals fed on yeast tastes good to humans.

68-0922

Ankudinov, N. V. Technology and economy in the use of scrap and industrial residues of iron metallurgy works and the metal working industry in the Soviet Union. *Neue Hütte*, 13 (5):260-264, May 1968.

The Soviet Union had to cope with 63.3 million tons of scrap and metal residues that went into the metallurgy industry,

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into special scrap working plants and into the machine industry. Presently the light scrap is packaged, the bulky scrap is cut. A table lists the technical data for cutting and packaging equipment. A second table compares the characteristic data of scrap presses and packaging machines of different capacities. More than 10 types of presses are presently used. Comparative efficiency calculations showed that the operating costs for packaging a certain amount of scrap are reduced with increasing capacity of the machine. To determine the range of highest efficiency of a packaging machine, the specific capital investment costs, the operating costs, and the capital spending costs, were calculated for a varying amount of scrap. The results showed that for an amount of scrap which keeps a press operating 70 percent of the time, a press with lower capacity should be used full time. The costs for cutting steel scrap with hydraulic cutters N-302 and N-630, alligator cutters N-316 and N-315, and with flame cutters, were calculated and listed. Hydraulic cutters have the advantage over the other two types in that the scrap need not be sorted; they have a higher capacity and lower capital investment and operating costs. (Text in German)

68-0923

Association for research in the re-use of slag from the iron and steel industry. *Tonindustrie Zeitung und Keramische Rundschau*, 92(5):185, May 1968.

A number of German iron and steel industries began to promote research in the field of blast furnace slag more than 10 years ago. A group was formed, and a research institute was established in Rheinhausen, Germany. Another work group was formed to deal with Thomas slag. Since it turned out to be more expedient to combine all research on the various types of slag, the two work groups merged on March 19, 1968 to form the *Forschungsgemeinschaft Eisenhuettenschlacken* (Association for Research on the re-use of slag from the iron and steel industry). The main purpose of this new association is to find new possibilities for the re-use of not only blast furnace slag but also Thomas and steel slag which is rich in phosphorus, and Siemens-Martin and steel slag which is poor in phosphorus. The demands of consumers concerning the quality of the slag increase constantly. Moreover, with the new oxygen-lancing process, a type of slag remains which can no longer be used in the furnaces of the integrated iron and steel industry. As far as the Thomas phosphate is concerned, it must be improved so that it can be better dispersed, but and this is the difficulty—the price should remain as low as that of ground basic slag. The association will concentrate its work mainly on the use of slag in the manufacture of building material, as an additive to cement and concrete, as filler in highway construction, and as a fertilizer. The characteristics of all types of slag as well as of slag products will be investigated, and a constant survey of the quality of slag products will be conducted. (Text in German)

68-0924

Auten, D. K. The acceptability of wastes formed in tomato production as feedstuffs for sheep. M.S. Thesis, University of Maryland, College Park, 1968. 58 p.

Tomato vines and tomato fruits were chopped, mixed with dry forages, and then ensiled in plastic bags. A preliminary ensiling trial was conducted for 30 and 60 days with tomato

vines, tomato vines plus grass hay, tomato fruits (green and ripe), and tomato fruits plus grass hay. Crude protein contents of the silage dry matter ranged from 10.51 percent to 12.35 percent for the materials ensiled 30 days, and up to 28.11 percent for those ensiled 60 days. Palatability trials showed that most of the preparations were accepted except for the tomato fruit silages. Wilted tomato vine silage was the most palatable, and had the highest content of crude protein. In a feedlot performance trial, it was found that all silages were consumed in quantities of 2.3 to 2.6 kg per lamb per day. The cannery waste plus corn cob silage produced the highest average daily gains (138.47 g) and the direct-cut tomato silage resulted in the lowest (49.94 g). Weight gains were generally related to dry matter intakes. Except when diluted by corn cobs, the experimental silages were all relatively high in crude protein (as high as 14 percent). Total daily dry matter intake from the tomato product silages was highest in the group fed the direct cut vines plus corn cobs and the lowest for the direct-cut tomato vine group. Digestibility of the direct-cut tomato vine silage dry matter was 56 percent in digestion trials conducted with four lambs.

68-0925

Auten, D. K. Review of literature. In *The acceptability of wastes formed in tomato production as feedstuffs for sheep*. M.S. Thesis, University of Maryland, College Park, 1968. p.4-25.

During the ensiling of high moisture forages, nutrient losses occur due to seepage and fermentation. The moisture content of the crop, the preservatives used, the size of the silo, and the fineness of chop all affect the amount of juice in the silo. The quality of silages is greatly influenced by the nature of fermentation. Silage is very palatable when correctly prepared and free of spoilage. Silage is also a relatively low cost feed, and there is little waste in harvesting and feeding. The waste portions of the U.S. vegetable crop is mainly leaves which can contain as high as 44 percent crude protein. Several experiments involving the feeding of tomato wastes to various animals are described. By treating oat straw with a cold diluted NaOH solution, the feeding value is increased. Pea vine silage was reported worth 91 percent, as much as good corn silage for dairy cows. Satisfactory feed lot performance was observed in animals receiving equal parts of shelled corn and cull beans with a small amount of linseed meal. Potato silage was fed to beef steers which was prepared by taking dry, chopped hay and grains and adding them to crushed potatoes and ensiling in trench silos. Beet tops and a portion of the root contain protein and sugar. A good quality beet top silage was made with tops wilted down to a moisture content of 60 percent or less.

68-0926

Auten, D. K. Experimental procedures. Results and discussion. In *The acceptability of wastes formed in tomato production as feedstuffs for sheep*. M.S. Thesis, University of Maryland, College Park, 1968. p.26-48.

All plant materials ensiled for the studies were sealed in polyethylene bags. While tomato plants were divided into ripe fruit, green fruit, and stems and leaves. These fractions were chopped and ensiled as such or mixed with ground grass hay to raise the dry matter content. The silage was sampled after 30 to 60 days of ensiling to note condition (appearance,

odor, state of preservation) and for analysis for dry matter, nitrogen, and volatile fatty acids. Silage was fed to sheep to determine acceptability. The lambs were divided into 6 groups and were assigned to silage treatments as follows: corn silage (control); wilted tomato vines; tomato vines and corn cobs; tomato vines (direct-cut); tomato cannery waste and corn cobs; and pelleted, dehydrated alfalfa (control). All silages with the exception of tomato vine silage at 60 days exhibited satisfactory ensiling results. The tomato fruit displayed little evidence of fermentation. In the palatability trials, the ripe fruit and green fruit silages were not well accepted. The wilted tomato vine silages were as high as 21.53 percent in dry matter crude protein while the direct-cut silages reached a maximum of 19.25 percent crude protein. The ash content was as high as 36.06 percent in a direct-cut silage preparation, and only as high as 19.64 percent for a wilted tomato vine silage. After an eight week feeding trial, the cannery waste plus corn cob silage yielded the highest average daily gains.

68-0927

Automatic baler with ingenious qualities. *Waste Trade World*, 112(10):14-15, Mar. 9, 1968.

A pushbutton-controlled, manual, semi-automatic, or fully automatic machine, with electrical systems that are matched to the requirements of the machine, is designed to produce dense bales from automobile scrap, new clips, trim scrap, or No. 2 steel. The Sheppard Harris Model TG1202 automatic baler is claimed to be able to produce bales up to 24 in. by 24 in. by 36 in. A 24 in. by 24 in. by 24 in. bale of light gauge new steel chippings would weigh 1,200 lb. It has an operating cycle of 37 loads per hr on full automatic repeat control. The loading hopper is 252 in. long by 92 in. wide, and the press box is 252 in. long by 60 in. wide by 70 in. deep. The machine has an operating pressure of 2,400 psi. The press produces bales with smooth surfaces, smooth corners and edges, and with no objectionable fins.

68-0928

Barnes, G. E. The economics of electroplating wastes disposal. *Plating*, 55(7):727-731, July 1968.

In order to reduce the concentration of objectionable contaminants in electroplating wastes, it is possible to provide sufficient dilution; to convert some of the toxic components to relatively non-toxic form; to precipitate the substances out of solution, and to dispose of the resulting sludge; and to recover some of the more valuable constituents for re-use. Examples are given of economic analysis as a major factor in considering a number of alternative disposal methods. Chemical equations to be used in determining cost of chemicals applied for partial and total destruction of toxicity are presented. Mechanics of controlled rinsing as a prerequisite for waste recovery and examples from practice are given.

68-0929

Baumann, G. M. Non-ferrous scrap re-cycling. In *Proceedings: First Mineral Waste Utilization Symposium*, Chicago, Mar. 27-28 1968. U.S. Bureau of Mines, and Illinois Institute of Technology Research Institute, p.117-122.

Approximately 3 million tons of non-ferrous scrap are handled each year, including 1,310,000 tons of copper and

copper base metals, 570,000 tons of lead, 665,000 tons of aluminum, and 230,000 tons of zinc, plus smaller quantities of nickel alloy scrap, stainless steel, precious metals, and other rare metals. Domestic secondary recovery supplies the United States with 20 percent of its aluminum needs, 35 percent of its copper, 45 percent of its lead, and 20 percent of the zinc. In the case of lead, much more metal is produced from scrap than is mined from domestic mines. The secondary copper, aluminum, lead, zinc, and nickel industries are examined.

68-0930

Bayler, H. Unscrambling your scrap waste problems. *Mechanical Handling*, 55(8):1,227-1,235, Aug. 1968.

Scrap and waste management must be the interest of any producer who wishes both to eliminate the liability of accumulating waste and to derive the maximum return on that portion of the scrap which is reclaimable. Eight positive steps for waste handling are suggested: reducing the amount of waste by determining at what point in the manufacturing process the greatest losses are occurring to see if they might be reduced; using waste on the premises by reprocessing if it proves economical; and selling scrap, keeping in mind that clear-cut loads and homogenous grouping of scrap may command a higher price. Letting or giving away waste material may be a solution, although storage and handling problems may still be costly. Incineration, which overcomes the need to transport bulky, low density material can be a solution if air pollution problems can be solved. Compressing scrap and waste reduces storage space and permits fewer pick-ups and higher payloads in less time. Hauling waste to a controlled tipping area depends on the availability of tipping space and the economics of getting it there. Paying for waste removal is the answer, if specialized handling and disposal facilities are not justified, and it offers the advantage of not tying up capital and labor on waste disposal.

68-0931

Bender, D. F., and T. C. Purcell. Reclamation of valuable compounds from agricultural refuse and municipal waste. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint E-3.)

The chemical approach is being used to search for organic chemical compounds of potential value in waste material resulting from the harvesting and processing of various plants and incinerator effluents, especially fly ash. The waste may contain a small amount of an extremely valuable compound, or the recovery of marketable compounds may defray the overall expense of a solid waste collection and disposal system. Preliminary work in the laboratory of the Solid Wastes Program of the Public Health Service indicates that the total extractable organics are present in very minute quantities in incinerator fly ash.

68-0932

Bergstrom, D. W. Economics of secondary fiber usage. *Tappi*, 51(4):76A-77A, Apr. 1968.

The economics of secondary fiber usage is initially based on a cost comparison between virgin fibers, pulp substitutes, and

Recycling

deinking grades of paper stock. The relative economic advantage of secondary fibers is determined through use of overdry fiber cost analysis, comparing only like fibers, e.g. hardwood vs. hardwood. As well as economic advantages, secondary fibers offer hydration and forming advantages, and they tend to produce a more dimensionally stable finished product. As compared with market pulp, secondary fiber should be produced at a cost advantage of \$20 to \$40 per ton to justify the capital expenditure and operating and maintenance costs of a deinking plant. Paper stock consumed in 1966 produced enough secondary fiber to replace the wood pulp from 50,000 sq miles of well managed forests.

68-0933

Block, P. D. Bright prospect for scrap in basic oxygen process. (Part II). *Materials Reclamation Weekly*, 113(8):24-25, Aug. 24, 1968.

A brief explanation of the heat balance in a furnace is given in order to clarify whether more scrap can be used in the basic oxygen furnace. If the scrap charge exceeded 30 percent, an inordinate amount of time would be needed to melt and reach tap temperature if, indeed, the scrap could ever be melted. There are two known methods of increasing the scrap percentage in the charge. One is to preheat the scrap with the attendant disadvantages of fuel cost and time required for the preheating. Fifty percent scrap charges have been achieved by adding chemicals such as calcium carbide or silicon carbide. The disadvantages of this include the cost of the additives, and the trend toward poorer lining life. A volume movement of scrap for consumption in basic oxygen, electric, and open hearth furnaces is foreseen for a long time to come. However, the scrap material must be cleaner and better prepared than ever before. This is forcing the dealer to install more sophisticated and more expensive equipment in order to maintain a competitive position. The dealer will also be faced with more closely controlled shipping schedules.

68-0934

Block, P. D. Challenges ahead—outlook good. *Materials Reclamation Weekly*, 113(7):26-27, Aug. 17, 1968.

A machine called a Calderon charger is used to introduce scrap into the furnace. Three-sided steel boxes, holding 85 tons (one charge of scrap), are loading in the scrapyard adjacent to the furnace building. Scrap used in basic oxygen furnaces falls into three general categories. Cushion scrap is used to protect the brick at the bottom of the furnace from the heavy scrap as it is charged. Materials such as slitter scrap, bushelling, flashings, and short clips are ideal for this use. Shredded scrap has not been used for this purpose because of the zinc content. The second type of scrap used consists of the normal grades which make up the remainder of the initial charge. Included in the mix are No. 1 bundles, detinned bundles, bloom butts, No. 1 heavy melting, and rail scrap. The restrictions placed on this type of scrap are that it must be free to galvanize, must be under 5 ft in length, and that heavy butts be used in limited quantities. The third type of scrap, coolant scrap, may be added in small quantities to reduce the temperature. Small electric furnace bundles, cold finished bar crops, rail crops, and miscellaneous railway scrap have proved satisfactory. The basic oxygen furnace has and will continue to cause changes in the scrap industry, but will by no means relegate it to a position of unimportance.

68-0935

Bludnen, G., S. B. Challen, and D. L. Woods. Seaweed extracts as fertilizers. *Journal of the Science of Food and Agriculture*, 19(6): 289-293, June 1968.

The use of seaweed as a manure is general in coastal areas throughout the world. Extracts derived completely or partly from seaweeds are used commercially in agriculture and horticulture. Brown seaweeds are similar to farm-yard manure in organic matter, nitrogen, and potash contents but contain more trace elements. Tests were carried out to determine the effects of different seaweed extracts on growth, and an attempt was made to relate these effects to the constituents of the extracts. Multipots, full of Vermiculite, were treated with 50 ml test solution or control liquid, and then sown with 30 mustard seeds. Records were made of the number of plants per pot, total wet weight per pot, and total dry weight per pot after the plants had been dried at 105 C overnight. The growth-promoting effect of extracts of *Laminaria saccharina*, *Fucus vesiculosus*, and *Ascophyllum nodosum* was due largely to the cations present, but this effect was modified by organic substances in the extracts. The concentrations of amino acids and mannitol in seaweed extracts had little effect on plant growth. The compounds extracted with organic solvents appear to be responsible in part only for the modification of the growth promoting effect. Alginic acid and its salts were indicated as being the main organic compounds responsible for reducing the effect of the metals with mustard plants. It is suggested that alginic acid competes with the plants by ion-exchange for the metals in the extract.

68-0936

B. O. C. idea speeds metal cutting task. *Waste Trade World*, 112(13):17, Mar. 30, 1968.

British Oxygen Company Ltd. has developed a metal cutting system using an oxygen-propane gas mix which, it is claimed, if large quantities are used, is cheaper than the more usual oxyacetylene. For thinner metals and long cuts, oxypropane is quicker than oxyacetylene, but the latter is better for thick metals and short cuts. The propane system has been installed in a scrapyard where the work of cutting up five steam locomotives is being carried out.

68-0937

Bodman, S. W. Appendix F. The compost-salvage operation. In *Summer study on the management of solid wastes; final report*. v.I. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. p.42.

The ultimate solution of the waste disposal problem lies in the combination of a compost-salvage operation plus sanitary landfill. With automated equipment, this process could be profitably operated by either a private company or a controlled agency. The most attractive landfill operation will combine rail haul with an efficient compaction process. The compacted material would preferably be wrapped in polyethylene films. Incinerators will gradually be displaced, since they cannot be operated efficiently, either technically or financially. The difficulty of control causes intractable air pollution problems.

68-0938

Bottle manufacturers start wide attack on solid-waste problems. *Waste Trade Journal*, 64(6):7, Feb. 17, 1968.

The Glass Container Manufacturing Institute is starting a long range program to solve the waste disposal problem of the industry's products, glass containers, and other packaging materials. Attention will be paid to such potential secondary uses for glass as a component of compost, manufacture of fiber glass, and the recycling of used bottles back into the glassmaking process.

68-0939

Bouwer, H. Returning wastes to the land, a new role for agriculture. *Journal of Soil and Water Conservation*, 23(5):164-168, Sept.-Oct. 1968.

Several projects are described which utilize agriculture's potential to purify sewage and other liquid wastes to add nutrients to the soil. The purpose of these projects may be either waste water renovation, in which case the applications may reach several feet per day or for irrigation purposes, several inches per day, or for both purposes. Renovation of sewage effluent or other low quality water by ground water recharge is less expensive than other forms of advanced water treatment for waste water re-use. Some figures given indicate treatment plants cost on the order of \$37 per acre ft to \$56 per acre ft, whereas recharge through surface spreading, depending on variables such as cost of land and topographical conditions, may run on the order of \$8 to \$15 per acre ft. Where irrigation benefits are obtained, the renovation scheme becomes even more attractive. The Flushing Meadows Project near Phoenix, Arizona, for groundwater discharge, is described. Some soil variables and pollution problems are considered, and nutrient benefits to be obtained from the sludge applications are given.

68-0940

Buchbinder, R. I. Revolutionary new system for pollution-free waste disposal. Paper No. 161. Presented at the 61st Annual Meeting, Air Pollution Control Association, St. Paul, Minnesota, June 26, 1968. 6 p.

Based on the age old process of producing charcoal, called pyrolysis, a system has been developed to economically convert municipal trash and waste materials into usable products. Municipal trash consists of 82 percent combustible material which can be carbonized producing two major end products, elemental carbon and combustible gas. The carbonization process requires that the combustible material be heated to temperatures above 750 F in an atmosphere which does not contain sufficient oxygen to support combustion. The system consists of a grinder that reduces the trash to a free-flowing material which is then ingested into a continuous-flow rotating retort, sealed to preclude the entry of oxygen. A converter processes combustible rubbish, garbage, cellulose material, plastics, neoprenes, synthetics solvent, woods, or any organic matter. Processing time is from 12 to 22 minutes. Approximately 20 percent of the original material is converted to carbon, and approximately 40 percent of the gases produced will be recycled to maintain the process on a self-sustaining basis. The balance is available

for other uses. Operating temperatures are in the range of 1,400 to 1,500 F. Two basic approaches to air pollution control are considered. Tests are being conducted to evaluate the system on a commercial basis. The system costs range from approximately \$5,500 per daily ton of capacity for a system capable of handling 200 tons per day, to \$3,650 per daily ton of capacity for a system of 800 tons per day.

68-0941

Carden, C. A., and J. F. Malina. Literature review. In Effects of waste paper additions on sludge filtration characteristics. Technical Report EHE 01-6801; CRWR-24. Austin, Center for Research in Water Resources, University of Texas, Jan. 5, 1968. p.3-17.

Vacuum filtration has found wide applications in the dewatering of sewage sludges in place of the use of drying beds. The advantages include economy, not being subject to weather conditions, routine performance and reduced digester requirements if the sludge is to be biologically stabilized. The development of current approaches to the design of sludge filtration systems is attributed to the work of Carman and Coackley who applied Poiseuille's and Darcy's laws regarding laminar flow through porous media. Carman's basic equation for a rigid cake is examined. The Buchner funnel test was used for experimental determination of values for specific resistance and compressibility coefficients of sludges under various prefiltration treatments. The new method of estimating specific resistance by correlation with capillary suction time as reported by Gale and Baskerville is discussed. Sludge characteristics which effect the filtration as listed by Trubnick are defined, and conditioners such as polymers and the eutriation process as defined by Genter are considered. Chemical conditioning of sludges and the physiochemical influence of lime as observed by Sontheimer are outlined. Advances in sludge dewatering, with the aid of fiber and waste materials as found by Carpenter and Caron, is mentioned. The proposed use of wastepapers, such as newspapers and magazines in a sludge dewatering process, requires that some attention be given to the quantities that are available. The geographic and economic feasibility in acquiring these materials should be studied.

68-0942

Carden, C. A., and J. F. Malina. Results. In Effects of waste paper additions on sludge filtration characteristics. Technical Report EHE 01-6801; CRWR-24. Austin, Center for Research in Water Resources, University of Texas, Jan. 5, 1968. p.31-47.

All tests with activated sludge indicated about the same results with the various conditioners at the optimum specific resistance. The effects of both newsprint and magazine paper on the specific resistance of digested sludge were improved with increases in the concentration of the solids. Conditioner demand was exerted by the liquid phase of raw sludge, but on a smaller scale than that of the digested sludge. Wide variations in compressibility coefficients were found in the sludges conditioned with newsprint. Over a range of solids concentrations from 20 to 80 mg per liter, the specific resistance of the pulped newsprint was about 1.0 times 10 to the seventh sq sec per g. The pulped magazine paper had resistances of about 3.5 times 10 to the seventh sq sec per g. At the 80 mg per liter solids concentration, the

Recycling

compressibility coefficients observed were about 0.3 and 0.6 for newsprint and magazine paper, respectively. The capillary suction filtration tests were found to be more replicable when the sludge was conditioned with liquids (polymers or ferric chloride) than when the pulped paper was used. Test results are plotted in graphs and presented.

68-0943

Chaliha, B. P., S. B. Lodh, and M. S. Iyengar. Utilization of waste paper for newsprint production. *Research and Industry*, 13(2):72, 76, Apr.-June 1968.

The development of a process for the production of newsprint from waste paper is described. A flow diagram of the process is charted. The deinking process consists of two steps: (1) disintegration of the paper and simultaneous detachment of the ink particles from the fibers; and (2) separation of ink particles from the pulp suspension. The conditions for disintegration or pulping vary widely. Removal of the ink particles is done by washing or flotation. The washing process is used mostly in the United States and the flotation process is used in Europe, where it has been introduced very recently. Characteristics of original and reclaimed papers of different grades are tabulated and compared, and production cost data are tabulated. The deinked waste paper stock from the flotation process is superior to mechanical pulp, due to the presence of chemical pulp fibers. Also, with increasing percentages of chemical pulp fibers in the stock, the strength of the paper increases. Wet strength papers, asphalt coated papers, polythene coated paper, waxed paper, and resin coated paper cannot be treated in this process. It is, therefore, necessary to sort the raw material before subjecting it to the deinking process.

68-0944

Clemons, C. A., and T. C. Purcell. Chemical and physical transformation of waste rubber into useful materials. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint E-7.)

Since waste rubber represents a potentially valuable resource and its disposal causes major problems, a study was undertaken by the Solid Wastes Program of the Public Health Service to determine the present and future possibilities of utilizing discarded rubber. Reclaimed rubber brings \$200 to \$240 per ton compared to about \$400 per ton for synthetic butyl rubber grade 1. Rubber manufacturers need an incentive to become interested in scrap rubber. The use of reclaimed rubber in such products as tire carcasses, passenger tire sidewalls, and undertread, molded goods, extruded and calendered goods, and automotive mats shows promise. Additional uses for whole used tires appear limited. New concepts in incineration of scrap tires and new uses for ground or crumb rubber may eliminate some problems.

68-0945

Conference of the association A.P. wrapping paper on the utilization of waste paper difficult to dissolve. *Das Papier*, 22(3):141-145, Mar. 1968.

A meeting was held in Ravensburg, Germany, by the Association A.P. [alte papier=waste paper] Wrapping Paper

on January 11 and 12, 1968. Detailed reports are given of the papers presented. G. Mickley discussed the 'Treatment of Waste Paper to Reclaim it as a Raw Material for Paper Production'. The demand for waste paper increased by about 10 percent during the period from 1953 to 1966. This is due to the fact that waste paper is used as raw material not only in the cardboard and carton industry, but also in the production of graphic paper. Various methods of converting waste paper into usable raw material are discussed briefly. In the last few years, the amount of bituminous waste paper has increased. The Jayme method used alkali to separate the bitumen from the fiber. J. Michael discussed 'Sorting Problems—their Possibilities and Limits'. The impurities suspended in an aqueous solution which contains fibrous material are retained on a sieve. They must be removed so that the holes do not become clogged. The removal creates great problems, and much attention has been paid to it. As a result, numerous systems and machines have been developed and these are briefly discussed. Any new method of separating impurities find new but narrowly limited possibilities for its application, some of which are cited. A paper, read by H. Ortner, discussed the separation of impurities from the waste paper. There are two types of impurities: heavy dirt such as iron and sheet steel parts, screws, sand, glass splinters, etc., and floating impurities such as string, plastic foil, bristles, etc. Separation in one stage, in this case, is not possible. The heavy dirt settles in the solvent, which serves not only to dissolve the waste paper but also as a preseparator. (Text-German)

68-0946

Conference of the association A.P. wrapping paper on the utilization of waste paper difficult to dissolve. *Das Papier*, 22(4):216-218, Apr. 1968.

The report of the meeting of the Association A.P. [alte papier=waste paper] Wrapping Paper in Ravensburg, Germany, is continued. A paper on the 'Technique of Dispersing Bitumen in Waste Paper' was read by H. Weib. For more than twenty years methods have been developed to remove bitumen from waste paper or at least to make it ineffective. All the methods are listed in a table; the principles of the various methods are indicated by key words. 'The Treatment of Bituminous Waste Paper by the Escher-Wyss Method' was discussed by W. Siewart. The bitumen is so thinly dispersed, that it no longer disturbs the smooth flow of the process or impairs the quality of the end product. A plant using this method includes a dehydrator which dehydrates the pulp from 3 to 6 percent to 20 to 30 percent solids contents, a device which tears up the continuous flow of fiber and produces small flakes, a heating spiral which heats the material to 95 C, and a disperser to disperse the bitumen. Experiments have shown that thermal treatment influenced the dispersing process favorably. Experiments to determine whether the Escher-Wyss process also influences the characteristics of bitumen produced positive results. White writing paper was pressed against a sheet of bituminous material at 143 C. It was found that the dispersion of bitumen reduces not only the size of the bitumen particles, but also their penetrating ability. The disperser has no adjusting device since the degree of dispersion is determined by the selection of operating conditions. Practical experience with the Escher-Wyss process has verified the findings of the developmental work in every respect. (Text in German)

68-0947

Conference of the association A.P. wrapping paper on the utilization of waste paper difficult to dissolve. *Das Papier*, 22(5):285-289, May 1968.

The report of the meeting in Ravensburg, Germany, is continued and concluded. G. Ryrberg discussed the Asplund defibrator method of converting waste paper into usable raw material. A table lists the amount of waste paper re-used in West Europe. The processing of waste paper for re-use is increasing. A diagram illustrates the upward trend since 1953. After treatment in a pulper, and after washing and dehydration, waste paper pulp is heated to a temperature of 150 C so that the bitumen melts. In the defibrator, which operates at high pressure and high temperatures, the bitumen is dispersed. W. Musselmann reported a new method for processing bituminous waste paper. By this method, a fiber material free of any bitumen is obtained. Waste paper is dissolved at temperatures between 65 and 80 C (melting point of bitumen) in an alkaline solution. The bitumen forms small balls which lose their stickiness as soon as the solution is diluted with cold water. They can then be separated easily. This method removes more than 95 percent of the bitumen. Various experiments with waste paper were carried out at temperatures below and above 100 C. It was found that pulp of a satisfactory quality could only be made at temperatures above 100 C, and only then was the pulp visibly clean. Unfortunately, high temperature reduces the strength of the paper. Experiments are now being conducted to find the causes of this. In another paper, a machine to process waste paper with a great wet strength was described. The last paper dealt with the finding of bitumen spots. The best method to discover the spots is the one described in TAPPI standard T 437 ts-63. (Text in German)

68-0948

Copper reclaimed without burning or stripping. *Waste Trade World*, 112(4):11-12, Jan. 27, 1968.

An invention which will separate copper from a wide variety of cables without resorting to burning or stripping utilizes a dry fluidized bed separator. Chopped cable materials are passed through a dry fluidized bed composed of titanium oxide through which air is passed, causing it to behave like a liquid. Materials, of a heavier specific gravity than the "liquid", sink, and the lighter specific gravities float. A plant designed to process 3,000 lb of scrap cables per hr has been in operation for 15 months.

68-0949

Dalton, F. E. Reclaiming land with Chicago sewage sludge. *Compost Science*, 8(2):5-8, Autumn 1967-Winter 1968.

The Public Health Service announced a grant to the Metropolitan Sanitary District of Greater Chicago for a project to determine whether processed liquid sewage sludge can be pumped through high pressure pipelines from Chicago to make marginal Illinois land productive for agriculture. A 10-acre, small-scale farm irrigation system for crop utilization of digested sludge will be constructed. Digested sludge is analyzed at 2.89 percent solids and 97.11 percent water, and is rich in nitrogen, phosphorous, and potassium. The proposal has the dual attraction of utilizing both the water and the

solids. The Metropolitan Sanitary District now disposes of sludge by four costly processes—heat drying, air drying, wet air oxidation, and treating in a heated digester. Disposal of as much as 75 tons per acre per year is expected to cost about \$15 per ton in comparison with the average of \$50 per ton now being spent. The University of Illinois's Department of Agronomy will investigate factors relevant to the contamination of surface and ground waters, the pollution ability of solids, and the method, frequency rate, and time for safely applying digested sludge on land.

68-0950

Decossas, K. M., L. J. Molaison, A. de B. Kelpfinger, V. L. Laporte, E. A. Gastrock, and H. L. E. Vix. New USDA process makes high-protein flour from cottonseed. *Food Engineering*, 40 (10):88-92, Oct. 1968.

The U.S. Department of Agriculture's Southern Utilization Research and Development Division has developed a mixed-solvent extraction process for producing high-quality edible cottonseed flour which would have an economic advantage in human nutrition in developing countries. Processing costs would range from 6.6 cents per lb of flour produced, when operating 270 days per year, and would be competitive with other commercial protein concentrates. Plant and processing costs are itemized. The extraction process includes: flake preparation and conditioning by moistening and heating; extraction with a solvent composed of 60 percent hexane to 39 percent acetone to 1 percent water at 110 to 115 F for 1 1/3 hr to reduce residual lipids in the meal to less than 1 percent; oil recovery and miscella refining; meal recovery; grinding and classification; and solvent storage and recovery. A flowsheet illustrates the acetone-hexane-water extraction of cottonseed.

68-0951

de Koe, W. J. Protein recovery from potato starch mill effluent. *Water and Waste Treatment Journal*, 12(2):55-57, July-Aug. 1968.

During the production of potato starch, a large number of by-products dissolved in the potato juice are released. These are difficult to remove, although they could usefully be applied. The Dutch Avebe factory developed two processes which can be applied to convert this waste material into a saleable by-product, and to reduce the BOD of the water, and thus make it a less offensive water pollutant. The end products of the potato starch mills are potato starch, potato pulp, which is used as cattle feed, and the diluted potato juice. There are two ways of producing potato starch: with rotosieves and with solid bowl centrifuges. When the latter method is used there is less dilution of the potato juices. The product, when it arrives at the protein producing plant, is first acidified to coagulate the globulines present in the potato juice. Via a heat exchanger, the product is fed into a coagulator where the protein flaked albumins are formed. From the concentrator, the protein concentrate is passed through a cooling unit to the filters. The filter cake is milled dried and packed in powder form. The same process is also described, as is used in Avebe, however here a spray dryer is used. Potato protein is high grade protein and is in much demand. The produce of either method results in 70 to 80 percent crude protein. It has been shown that, if the potato

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starch plant is efficiently managed, protein recovery is economical. Also the BOD of 180,000 mg for diluted potato juice supplied to the plant is reduced to approximately 6,000 mg per liter. If the coagulation protein has been removed, it is possible to continue the purification by manuring, fermentation in lagoons and with *Torula utilis*, and active sludge treatment.

68-0952

dePadilla, F. H., and F. H. Hoskins. Hydrolytic conversion of sawdust into metabolizable sugars. *Journal of Agricultural and Food Chemistry*, 16(5):735-737, Sept.-Oct. 1968.

The hydrolytic conversion of sawdust and pure cellulose powder was studied by sulfuric acid-enzymatic and sodium hydroxide-enzymatic treatments. Cellulose powder yielded dextrose in concentrations ranging from 2.2 to 2.9 g per 100 g, while sawdust yielded dextrose and xylose in concentrations ranging from 3.0 to 4.2 and 1.0 to 6.7 g per 100 g, respectively. Under optimum conditions, the total concentration of sugars was 10.8 g per 100 g. Since sawdust is inexpensive, and both sugars are available to the human digestive tract, further work can commercialize the process.

68-0953

Designed by reclaimers for reclaimers. *Materials Reclamation Weekly*, 112(21):11, May 25, 1968.

The Hydracut 40 hydraulic alligator shear, produced by Hill and Gilbert Ltd. of Great Britain, was designed to meet all the demands of metal processors. Provided with push-button automatic or manual control, the machine is of heavy cast steel construction and can be powered by electricity or a diesel engine. The cutting blade is 24 in. long, and the maximum opening width between the blades is 12½ in.

68-0954

Device for regenerating newsprint. *Das Papier*, 22(5):280, May 1968.

Guillaume Duchange of Neuilly-sur-Seine, France has obtained a German patent for a device to regenerate newsprint. He also holds the patent. He applied for the patent in Germany on June 27, 1961, and the patent was granted on August 3, 1967. He also applied for a French patent on June 30, 1966 which was granted on June 15, 1961. The number of the French patent is 831,591, of the German patent 864,991. (Text in German)

68-0955

Diehl, H. Power plant in the wood industry fired exclusively by chaff. *Energie*, 20(11): 331-337, Nov. 1968.

Since much chaff and sawdust accumulates in the wood industry, it was decided to use this material as fuel for a nearby power plant. The boiler furnace, fired by such wood residues, consists of three flues and a chain grate stoker. The furnace walls are water jacketed, and a shell of sheet steel surrounds the entire furnace. It has been designed for a capacity of 8 to 10 tons per hr of steam. At the outlet of the superheater, the steam has a pressure of 30 atm gauge and a temperature of 400 C. The storage room consists of two parts—one for the wet chaff, the other for dry sawdust etc.

Each half of the storage bunker holds 135 cu m. A screw conveyor brings the fuel to a transport blower, which passes it on to the hopper. It proved to be advantageous to mix the dry sawdust with the wet chaff for better combustion. Bulky wood parts can be charged by hand. To obtain the required purity of steam, it is decarbonized and desilicized at temperatures between 60 and 70 C. The turbine has a maximum capacity of 800 kw. In the 3 to 4 years the plant has been in operation, it has operated satisfactorily. An average of 7.5 tons of steam were produced per hr at a fuel consumption of 1.64 tons per hr. The heating value of the mixed chaff and sawdust was on the average 3385 kcal per kg. The average power output was 815 kw, of which 94 kw were consumed by the power plant itself, and 721 kw were sold. (Text in German)

68-0956

Digesting the news. *News Time* (Scholastic Teacher's Edition), 31(14):2, Jan. 18, 1968.

For 56 days, cows ate a newspaper-molasses mixture costing less than grain. Wood pulp is nutritious and molasses makes paper digestible. Waste-paper food can reduce problems of too much rubbish and insufficient grain.

68-0957

The disposal of solid wastes. In *The secondary material industries and environmental problems. Studies of Dislocation Factors No. 2*. New York, National Association of Secondary Material Industries, 1968. p.8-9.

The role that the secondary material industry plays in recovering and reprocessing high tonnages of material, which normally might end up as solid waste, is assessed. By expanding the utilization of secondary materials, uneconomical material can be transformed into a potentially valuable raw material. Metals recovery is one project directly related to various industrial and liquid waste disposal problems. The displacement of the secondary industry because of urban renewal and highway construction means that small dealers have been put out of business, and when small collectors are out of business, potentially utilizable raw material lies abandoned and uncollected.

68-0958

Does advanced plant waste non-ferrous scrap? *Waste Trade World*, 112(8):11, Feb. 24, 1968.

The National Research and Development Corporation sponsored the production of fertilizer from household waste. In this process, ferrous metals, reclaimed from the refuse, are automatically baled in 10-lb packs. Non-ferrous metals are scraped off and thrown away, together with fragmented rubber and other perishable items. It is believed that modifications could be made in the system to recover non-ferrous metals, if the presence of such metals was great enough to make it a profitable undertaking.

68-0959

Economics of overhead cranes. *Materials Reclamation Weekly*, 113(6):30, Aug. 10, 1968.

The problem of moving metal into lorries was solved by James Thomas & Son Ltd., of Birmingham, by the purchase

of an overhead crane produced by Herbert Morris Ltd. The 5-ton Centralift overhead travelling crane is fitted with a magnet, and it gives full coverage of the 90-ft long scrapyard. The speed of servicing trucks allowed one vehicle to be cut out of the fleet. The electric crane is cheaper to run than the old diesel mobile crane. Reduced repair and maintenance time is anticipated.

66-0960

Evans, J. O. Using sewage sludge on farmland. *Compost Science*, 9(2):16-17, Summer 1968.

Pennsylvania farmers, who have been receiving digested sludge from municipal waste treatment plants on their fields, report no objectionable odors and greater field production for corn, hay, oats, and clover. According to a recent survey, about 30 Pennsylvania municipalities are disposing of liquid digested sludge to land surfaces in once-a-year to quarterly dosings. In addition to plant nutrients, sewage sludge supplies water and humus to soils. It acts as a soil conditioner and promotes increased porosity for better air and water movement. Sludge applications are made by various methods including gravity flow from discharge hoses, spreading under pressure from specially designed applicators, and by the use of various types of spray equipment. Spreading or spraying is discontinued during rainy weather, kept away from drainageways, and it is not practiced on vegetable crops. At present, sewage plant operators are supplying sludge without charge.

68-0961

Feeding livestock with newspaper? *Das Papier*, 22(2):99-100, Feb. 1968.

A mixture of molasses and ground newspaper was fed to young cows for a period of 6 months by scientists of the Pennsylvania State University. The cows were reported to have gained an enormous amount of weight. A control group fed regular food did not gain more weight. Molasses, a by-product of sugar production, cannot be fed in larger amounts to livestock, since it would deprive the body of too much water and the molasses would accumulate in the stomach as a tough cake. Scientists, therefore, mixed molasses with ground newspaper. Albumin was added in the form of soy bean flour. The control group was kept on a regular diet of cracked corn and soy bean flour. They gained some weight during the test period of 56 days, but their general condition did not improve. The molasses-newspaper mixture may be a great help in feeding livestock, especially where there is a shortage of regular food. (Text in German)

68-0962

Fagan, R. D. Kinetics of the porteous hydrolysis process; hydrolysis of paper; progress report no. 1. Hanover, N. H., Thayer School of Engineering, Dartmouth College, Nov. 6, 1968. 23 p.

Recognizing that approximately 60 percent of refuse is paper, Porteous suggested that the cellulose be hydrolyzed to sugars with subsequent fermentation to produce ethyl alcohol. He based his economic analysis on the assumption that the kinetics of wood chip hydrolysis, as reported by Saeman, would apply. Furthermore, he assumed that they could be extrapolated to slightly higher temperatures where the yield is greater, and the amount of sulfuric acid required

is less. Porteous based his economic analysis on a yield of 55 percent at 230 C with 0.4 percent sulfuric acid. Experiments presented in this report were limited to temperatures below 217 C. These kinetic data indicate that a yield of 45 percent is obtainable at 230 C with 0.5 percent sulfuric acid. Economic analysis indicates that this yield corresponds to a profit of \$1.04 per ton, rather than the \$4.21 predicted by Porteous. The yields were found to be much less when carried out in a 316 stainless steel container. This indication of iron inhibition indicates that the process might be sensitive to the separation of metals from the refuse. Experiments in the future will be directed toward: (1) comparison of enzymatic and acid hydrolysis; (2) effects of metals on acid hydrolysis; (3) effects of other components on hydrolysis; and (4) the effect of using a higher temperature and shorter residence time.

66-0963

Ferrous metal reclaimed by new refuse plant. *Materials Reclamation Weekly*, 113(5):21, 23, Aug. 3, 1968.

Twelve to 15 tons of scrap ferrous metal, mostly old tin cans, are being recovered by Barrow-upon-Soar Rural District Council since work started with a £250,000 refuse incineration plant in June 1968. The metal is put through a two-phase operation; first, extracting tins magnetically as the refuse is sorted, and then running the week's clinker through the magnet to reclaim any which have been missed. The plant, consisting of a handling plant, two incinerator units, a pick-up conveyor and a scrap metal baler, handles 70 tons per 8 hr day of refuse. Gases from the incinerators pass through a water trap grit arrestor on the way to the chimney.

68-0964

Florida garbage plant offending St. Petersburg residents. *Clean Air News*, 2(5):22-23, Feb. 20, 1968.

A refuse reclamation plant, located in a prosperous residential section, and built less than 2 years ago for \$2 million as a pilot project, has been ordered closed down because of bad odors. The facility took 600 tons per week of garbage and produced 'cura' soil conditioner, and with the addition of a \$60,000 blender, made 'cura-soil' fertilizer. The owner is the International Disposal Corporation which is owned one third by Westinghouse Electric, one third by Allstate Insurance, and most of the remaining third by Salvage & Conversion System.

68-0965

Flotation processing of waste paper. *Das Papier*, 22(4):205-206, Apr. 1968.

Austrian patent No. 258,696, obtained by Farbwerke Hoechst AG, on Dec. 11, 1967, was applied for on Aug. 14, 1963. Priority was obtained in Germany on Aug. 16, 1962. The patent was granted for a flotation process to remove the carbon black from newsprint. (Text in German)

68-0966

From scrap...to iron powder. *Precision Metal Molding*, 26(10):64-67, Oct. 1968.

A pilot plant of Peace River Mining & Smelting, now under construction in Alberta, Canada, will produce a low cost,

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high-quality iron powder from low-grade steel scrap. The process dissolves the scrap in hydrochloric acid, producing a ferrous chloride solution that is filtered, concentrated, and evaporated. This material is then reduced to iron by reacting it with hydrogen. Hydrochloric acid is formed as a byproduct of the reduction step, and it is recycled back to the dissolver.

68-0967

George, H. D. The handling, processing and marketing of steel-making slag. In *Proceedings; First Mineral Waste Utilization Symposium*, Chicago, Mar. 27-28, 1968. U.S. Bureau of Mines, and Illinois Institute of Technology Research Institute. p.80-83.

The slag contains limestone or dolomite. After introduction into a steel-making furnace, it is melted at a temperature of 2,900 F to separate and remove the impurities from the nascent steel. Disposal of this slag from open hearth, basic oxygen, or electric furnaces has become a problem, since the cost of disposal is high, and dumping areas are scarce, and maintenance requirements are great. Therefore, methods for reclamation have been developed. The slag is cooled and the metallic portions are removed by magnetic separation. The metal-free slag is discharged onto vibrating screens and is then fed into crushers. The pulverized slag may then be used for blast furnace flux (after adjustment of the pH), anti-skid for highways, railroad ballast, road sub-base and shoulder construction, temporary roads in muddy or swampy terrain, river bank protection, bituminous concrete, and golf course greens.

68-0968

Gouwens, P. R., and E. Aleshin. Utilization of foundry waste by-products. In *Proceedings; First Mineral Waste Utilization Symposium*, Chicago, Mar. 27-28, 1968. U.S. Bureau of Mines, and Illinois Institute of Technology Research Institute. p.84-98.

Foundry waste material was analyzed in order to provide enough information to determine as many marketable uses as possible. Attempts were made to pelletize each material, and the pellets produced were characterized as to burning properties, bulk density, phases present, and strength. Arc furnace and sand reclaimer dusts were found to be composed essentially of small particles which could be easily pelletized and burned in a rotary kiln. Crushing strength measurements showed that the furnace dusts form rather dense, strong pellets which show promise as aggregate in masonry products and grog in structural clay products. The high iron content of furnace dust pellets indicate that they may be more amenable to recycling in a melting furnace. The low surface areas for these materials preclude utilization as fertilizer and insecticide carriers. Pore volume and density measurements show that the furnace dusts may possibly be used as insulation in chemical processing, and they can be foamed easily, indicating possible use as structural insulation. Both furnace effluents and sand reclaimer dust show promise as pigments. It may be possible to utilize the property of sand reclaimer dust to gel when added to water, for fill stabilization. All of the powders tested form dark glasses with short working ranges. Cupola wastes may possibly be used as soil conditioner and as a source of micronutrients. Free steel from shot blast dusts can be separated and reprocessed.

68-0969

Grinding material for the cement industry. *Silikattechnik*, 19(8):262, Aug. 1968.

A new slag utilizing plant began to operate in Germany in May of 1968. In this plant, blast furnace slag is prepared to be used in the cement industry. The personnel of the plant intends to handle about 220,000 tons of slag for the cement industry until the end of this year. The plant has been built to satisfy the increasing demands of the cement industry for blast furnace slag. All the slag which is dumped at present can be utilized now so that imports are no longer needed. The prepared slag is delivered by trucks or trains to the cement plants. (Text in German)

68-0970

Harding, C. I. Recycling and utilization. *Compost Science*, 9(1):4-9, Spring 1968.

Most recycling and utilization schemes involve some type of salvage and composting. All composting operations can be broken into three basic steps: refuse preparation including receiving, sorting and salvaging operations, grinding, and the addition of moisture and nitrogen; stabilization or aerobic digestion either in windrows or mechanical plants; and produce upgrading which includes curing, screening, pelletizing, drying, and bagging. The new TVA-PHS Demonstration Compost Plant at Johnson City, Tennessee, is of the windrow type. The three mechanical systems which have proved successful in composting in the U.S. are: the Fairfield system; the International Disposal Corporation (IDC) system, formerly known as the Naturizer system; and the Metrowaste system. Capital costs, energy, and labor requirements for the three systems are compared. By separating the financing of composting into two phases—disposal phase, underwritten by dumping fees; and by-product phase, paid for by compost sales—a realistic approach to financing composting plants can be taken. The best potential bulk market for compost is as a building material in the fertilizer industry.

68-0971

Hawk, C. O., S. Friedman, E. B. McCullough, and R. W. Hiteshue. Refuse mulch boosts tomato yield. *Coal Age*, 73(6):92-94, June 1968.

In a small field experiment involving 100 tomato plants, half of which were mulched with coal-working refuse, the mulched plants grew faster and bore more and larger fruit than unmulched plants. The increase in yield was greatest up to about midseason. The yield ratio (yield of mulched plants divided by yield from unmulched plants) for ripe fruit during this period was 1:2 to 1:3. This ratio for the entire season was 1:13. The increased yield is believed to result in large measure from the dark-colored mulch capturing more solar radiation, consequently producing a warming effect in the soil. There was no evidence either of poisoning the plants by the mulch or a beneficial effect attributable to a nutrient property of the mulch. The results suggest the need for studying the problem on a much larger scale, and probably with a variety of crops.

68-0972

Hell, K. W., and D. Schiønsen. A new unit for spraying sewage sludge, manure, and waste water over the fields. *Landtechnik*, 23(21): 726-727, Nov. 1968.

The disposal of sewage sludge has always posed special problems. The sewage sludge is very often dried and then used as fertilizer by farmers. The Schlebusch Company refined its system of spraying sewage sludge, manure, and waste water over the fields. The unit consists of an axle with a frame upon which a winch is mounted. The winch winds up a polyethylene hose with varying speed depending on the amount of manure or sludge to be spread over the field. The hose has an adjustable spray nozzle attached on one end which rests on a support. This support is dragged along across the field. Tests were made on the length of the hose. Too long a hose would sag too much between the support and the winch and could damage the crop. It was found that not only the length, but also the amount of liquid pressed through the hose and the height of the crop, must be considered. Generally, a hose length of 300 m for high crops (such as rapeseed, lupine, etc.) and 400 m for low-lying crops can be considered as safe. The winch has an inner diameter of 1,400 mm and an outer diameter of 2,100 mm. It is 1,000 mm wide and is operated by a driving shaft. The price of the entire unit including a hose of 200 m length is DM 7,000. (Text in German)

68-0973

Hesch, R. Pressboards made of bagasse for the building and furniture industries. *Zuckerindustrie*, 18(3):114-120, May 1968.

Between 1965 and 1966, a new pressboard manufacturing plant, using bagasse as raw material, began operation on the Reunion Island, east of Madagascar. The plant produces 42 tons of product per 24 hr. The pressboards are 8 to 35 mm thick, and have a specific weight of 300 to 750 kg per cu m. At present, the plant operates only during July to December when the sugar cane harvest is under way. The plant has no storage place for the bagasse, but preparations are going on in this respect so that the plant will operate throughout the year beginning in 1968. Since the plant has been operating for 2 years, the bagasse pressboards appear to be a success. They are comparable to wooden pressboards as far as the quality is concerned. The bagasse boards have the advantage of greater homogeneity, but less impressive are their drab colors which vary from a light green-grey to brown-grey. The demand for the boards is higher than the plant is presently able to produce. The chemical composition of bagasse is very similar to that of wood. Fresh bagasse leaves the sugar factory with high moisture contents and must be dried first (which is not necessary if stored and compacted bagasse is used). The pith is removed in two steps. After another drying process, the material is ready to go to the press. The type of press used in the plant on Reunion is illustrated and described in detail. A qualitative comparison of the bagasse pressboards with pressboards made of wood, hemp, and jute, etc., is given. The bagasse boards are mainly used for heat insulation in the construction of houses. (Text in German)

68-0974

Hillyard, H. E. Recovery of waste oil using floating-type skimmers. *Iron and Steel Engineer*, 45(8):77-80, Aug. 1968.

Construction of a lagoon for trapping waste oil from a steel plant was accompanied by the use of skimmers, to remove the oil from the surface of the pond. The oil was a mixture of most of the different types of oils used in rolling and pipe mills, including: lubricating oils, threading oil, cutting oil, fire resistant fluids, and compounds and grease mixed with the oils. An estimate of the amount of oil was in excess of 500 gpd. A belt type skimmer was used to recover the oil which collected in front of the discharge weir. The skimmer consists of a neoprene continuous belt, and it can have rated pickup capacities of 30, 40, 50, and 70 gph, depending on belt width. Two floating skimmers were purchased for the removal from the rest of the 13 acre lagoon. They consist of self-contained units, approximately 6 ft sq by 3 ft high. Two fiberglass reinforced epoxy plastic rollers dip into the oil film which adheres to them, and is then scraped off. A minimum of maintenance has been required. The waste oil is used as boiler fuel at the plant and has caused only minor problems.

68-0975

Hinesly, T. D., O. C. Braids, R. I. Dick, et al. Disposal of digested sludge on farm land. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. (Conference Preprint D-7.)

Research is being carried out to make a quantitative evaluation of: the most practical amounts, frequency, and economical method of applying anaerobically digested sludge on crop land throughout the year; the probability of contaminating surface runoff and drainage water with pathogens and soluble or suspended organic and inorganic substances; the changes in soil characteristics to be expected from frequent applications of digested sludge; and the supplemental fertilization of crops that will maximize the benefit of nutrients supplied by digested sludge. Research facilities consist of 44 plots of three different soil types, isolated from the surroundings by a continuous sheet of nylon reinforced plastic which is buried to a depth of 6 ft as a plot border. Equipment for measuring and recording total runoff and drainage water is provided for each plot.

68-0976

How to save sulfate: convert it to cash. *Chemical Week*, 102(3):64-65, Jan. 20, 1968.

Gypsum (calcium sulfate), which is often a waste product of phosphate rock digestion in a typical phosphoric acid plant, is ammoniated in the Baroda, (Gujarat state) India, plant. The plant, built with the help of Hitachi Shipbuilding and Engineering firm (Japan), uses the Nissau-Monsanto process for sulfuric acid to produce 155,100 metric tons per year of ammonium sulfate (AS). It may be blended with the conventional product, diammonium phosphate (DAP), to give up to 267,300 metric tons per year of AS/DAP mixed fertilizers. Co-produced are more than 100,000 metric tons of fertilizer-grade urea, as shown on a flowsheet diagram. Included in the process is also Chemico's one-step digestion of phosphate rock for making phosphoric acid, concentrated to 40 percent, yielding 54,450 metric tons per year. The Gujarat plant seems to have the largest capacity of such plants. In the United States, ammonium sulfate is recovered from slot-type coke ovens or as a by-product of caprolactam

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manufacture. Some U.S. chemical companies are planning to use waste gypsum, but these plants are still on the drawing board, stymied by the high costs of gypsum reclamation. However, at least one installation is planned at Yazoo City by the Mississippi Chemical Company.

68-0977

Induction furnace duplexing improved quality of malleable iron castings and reduces scrap losses. *Industrial Heating*, 35(4):666, 668, Apr. 1968.

Significant reduction of casting rejects has been achieved by using a 20-ton, 1,100 kw channel-type induction drum furnace to duplex malleable iron from an arc melting furnace at the Erie Foundry of General Electric Company. The duplexing furnace holds the exact temperature required for good pouring and gating practice. The metal is thoroughly mixed, ensuring a controlled uniform chemistry. Base metal consisting of pig iron, foundry returns, and scrap is batch-melted in an electric arc furnace, tapped at 2,900 F into an 8-ton ladle, and transferred into the induction furnace. The induction furnace is usually tapped at 2,900 F into an 800-lb pouring ladle.

68-0978

Industrial waste can be an asset. *Water and Waste Treatment Journal*, 12(1):17-18, May-June 1968.

Spent liquor from pickling vats at steel mills and fabrication plants contains up to 15 percent free sulfuric acid, and up to 20 percent iron sulfate dissolved in water. Other impurities, such as metal sulfates, metal sulfides, lubricants, inhibitors, and hydrocarbons may also be present. The only practical method of disposal has been to neutralize the liquor with lime and then settle the resultant slimy, grey-green sludge in lagoons. Recently, du Pont has patented a process for waste pickle liquor. This process yields two marketable by-products: magnetic iron oxide; and gypsum, the principal ingredient of cement and wallboard. In operation, spent liquor that has been discharged from a pickling line into a holding tank is pumped into a reactor vessel, along with a specified volume of lime and water. With the lime serving as a neutralizer, the resultant slurry is subjected to agitation. Live steam is fed into the reactor to maintain a temperature of 190 F, while air is sparged or blown into the mixture. Air oxidizes the iron present in the waste pickle liquor, causing precipitated iron hydroxide to grow gradually into particles of black magnetic iron oxide. Calcium from the lime joins with sulfur and oxygen to form crystalline hydrous calcium sulfate or gypsum. At this point, the two compounds are easily separated. By passing the reactor slurry through magnetic drums, as in the processing of taconite ore, marketable iron can be extracted. The treated output of a plant using 100,000 gallons of pickling liquor a day contains about 33 tons of iron oxide and 148 tons of gypsum. The chief economic value of the residue probably lies in its convenient disposability as clean landfill. Experiments have shown that the residual solids are essentially insoluble, and they will not leak back into and contaminate the soil.

68-0979

Industrial wastes. In *Proceedings; First Mineral Waste Utilization Symposium*, Chicago, Mar. 27-28, 1968. U.S. Bureau of Mines, and Illinois Institute of Technology Research Institute, p.79-122.

This symposium marks the first time that a meeting of national stature has been held to identify mineral waste materials, as well as to describe what is being done about their utilization. The third session concentrated on industrial wastes, emphasizing such topics as the handling of steel-making slag; fly ash utilization; solid wastes in the ceramic industry; ferrous and nonferrous scrap recycling; and slurry pipelines.

68-0980

Introducing the 'Superlift'. *Materials Reclamation Weekly*, 112(19):19-20, May 11, 1968.

A truck mounted hoist, the 'Superlift', whose capacity is 3½ tons, is being marketed by Powell Duffryn Engineering. It extends 21 ft. The swing mechanism is totally enclosed and gives a slewing arc of 360 degrees from left to right. The hoist lifts up to 7,700 lb at a 58-in. jib length. A feature of the 'Superlift' is that it can be fitted to any chassis or truck model, being driven by an integral pump fitted on the gearbox. One interesting application from a scrap merchant's point of view, is its ability to hoist abandoned vehicles from difficult positions.

68-0981

Iron and steel scrap in 1967. *Waste Trade Journal*, 64(2):2, Jan. 13, 1968.

Reflecting lower steel production, the generation and consumption of iron and steel scrap in 1967 fell below the high levels of the previous 2 years, according to the Bureau of Mines. Home scrap production declined 5 percent, receipts of purchased scrap 12 percent, and total ferrous scrap consumption 6 percent from 1966. Consumption of scrap by the steel industry decreased more than consumption by foundries, due to the continually increasing use of the basic oxygen furnace in steelmaking. Prices declined 12 percent along with the reduced demand for the scrap. There was a sharp rise in exports, 8 million tons, with Japan taking over 70 percent of the total U.S. exports in 1967. Three additional super-shredders for converting junked automobiles to useable scrap went into operation at Cleveland, Detroit, and Everett, Massachusetts. Research to increase use of scrap iron and steel continued in private and industrial laboratories.

68-0982

ISA—a case history in diversification. *Waste Trade Journal*, 64(34):3, Aug. 31, 1968.

A Louisville firm, realizing that scrap metal processors who devoted their entire business to scrap would be in a position of insecurity due to fluctuating prices, expanded its services to include collection of industrial waste. A spin-off corporation, Industrial Services of America (ISA), takes the industrial waste wood and paper, shreds and compacts the materials into bales, and sells the bales to manufacturers of cardboard, paper pulp, or fiberboard. For every shipment of incoming waste material received, only one truckload of unsalvageable residue is channeled to the company-operated sanitary landfill.

68-0983

Japanese companies convert leather scraps into a material that can compete with synthetics. *Waste Trade Journal*, 64(7):7, Feb. 24, 1967.

Three Japanese companies are converting leather scraps into a hybrid material that is expected to compete with real leather as well as synthetics such as Corfam and Aztran. The scrap, called clippings, are reduced chemically to a pulp which is sorted for fibers of a certain length. The fibers, 1.2 in. to 2.7 in. long, then are pressed into continuous sheet which can be cut, dyed, and shaped. A U.S. plant hopes to begin commercial production of a similarly modified leather which will cost probably between \$.50 and \$.60 per sq ft.

68-0984

Jernstrom, K. E. Finns operate the world's first sawdust market pulp mill. *Paper Trade Journal*, 152(52):34-35, Dec. 23, 1968.

In June 1968, Oy Kaukas AB began operating a 100 ton per day plant producing unbleached kraft pulp from sawdust. The digester is a Bauer M & D type, equipped with a Bauer feeding valve as well as with an 8 cu m retention digester. Pulp for export is dried to a dry content of 90 percent, while pulp for the domestic market is lapped at a dry content of 50 percent, and strapped into large bales. In paper-making properties, this pulp resembles birch kraft pulp.

68-0985

Jochens, P. R., C. W. Wolhuter, and D. D. Howat. Utilization of slags for the manufacture of cement. A rapid technique for the assessment of the characteristics of raw materials. *Journal of the South African Institute of Mining and Metallurgy*, 69(5):217-228, Dec. 1968.

The use of milled, granulated, blast-furnace slag for cement is well-established in South African building and civil engineering, but little information is available regarding the suitability for this purpose of slags from electric arc furnace smelting in the ferro-chromium industry. A rapid method, based upon the use of a micro differential thermal analyzer, for the investigation of the composition modifications required to make such slags acceptable as construction cements was investigated. An index, combining composition modulus and glass content was found to provide a possible, reasonable basis for the rapid assessment of the effect of modification of composition on the strength of cement made from a new slag.

68-0986

Junk yard goldmine? *Industrial Research*, 10 (7):20, July 1968.

The Department of Interior's Bureau of Mines regards trash heaps as valuable sources of uranium, yttrium, aluminum, iron, zinc, copper, lead, and tin. Copper can be 'sweated' out of scrapped electrical equipment, salvaging millions of pounds of discarded copper annually. Scrap material is immersed in a 1,250 C molten salt bath and agitated for a few minutes. Copper melts quickly, 'sweating' off the scrap, and

collecting in the bottom of the vessel. Iron and steel are not affected at this temperature. The salt bath is reusable, and the process prevents oxidation and alloying. The nation's 165 million tons of trash per year can be a source of valuable raw materials. One billion dollars worth of ferrous and nonferrous metal can be separated from previously worthless trash piles.

68-0987

Kayama, N., and H. Nakae. Study on the position of steel scrap in a layer of charged metal in cupola operation. *Journal of the Japan Foundrymen's Society*, 40(8):654-662, Aug. 1968.

Considerable amounts of steel scrap are often charged into the cupola, together with pig iron and return scrap. Since steel has a higher melting point than the other materials, the charging manner of steel scrap, that is, the relative position of steel scrap and the other materials in a charged metal layer, would affect the cupola melting process. Experiments were performed to clarify this process, and results indicate that when steel is put into the lower part of the charge, cast iron at the upper part would not be able to melt rapidly and both materials would melt down simultaneously at a lower level. (Text in Japanese)

68-0988

Kenahan, C. B., P. M. Sullivan, J. A. Ruppert, and E. F. Spano. Composition and characteristics of municipal incinerator residues. U.S. Bureau of Mines Report of Investigations No. 7204. [Washington], U.S. Department of the Interior, Dec. 1968. 20 p.

The Bureau of Mines is developing methods for reclaiming the metal and mineral values contained in municipal incinerator residues. This report describes the first phase of the research in which reliable methods for sampling and analyzing municipal residues were established, and the composition and characteristics of the residues were determined. Samples were obtained from a variety of grate-type furnaces and from a rotary kiln furnace. They were processed on a batch basis and separated into categories by a variety of methods including screening, magnetic separation, air separation techniques, and handpicking. The main components of the residues were determined to be metal and metal oxides, glass, and ash.

68-0989

Kilpper, W. Annual meeting of the Swedish Association of Engineers of the Paper and Cellulose Industry (SPCI) between March 25 and 27, 1968. *Das Papier*, 22(7):406-411, July 1968.

The 60th annual meeting of the Swedish Association of Engineers of the Paper and Cellulose Industry was held. Only one paper presented was pertinent to the field of solid waste disposal. It dealt with experiences gained in sawdust digestion in Kotka, Sweden. Since the spring of 1964, sulphate cellulose has been made of sawdust in the Kotka plant of the company, Enso Gutzeit Oy. The digestion is performed with a Bauer M & D digester whose capacity of 1967 had to be doubled to 100 tons. This was possible by installing a larger

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intake pipe and by reducing the digesting period from 30 to 15 minutes. The pressure had to be increased from 8 to 10 kg per sq cm, for the digestion must be free of any sand and dust. About 1.5 to 2 percent of the production is rejected. The steam consumption decreased after the modification of the digester by 30 percent to 1.2 Gcal per ton. The digested sawdust goes to the neighboring cellulose plant. It is used as an additive in the production of sack and bituminous paper. Up to 10 percent sawdust can be mixed with ordinary sack paper without impairing the quality. (Text in German)

68-0990

Klein. Method of treating waste paper. *Das Papier*, 22(8):L80, Aug. 1968.

R. W. McKinley (Packaging Corporation of America) obtained U.S. patent No. 3,361,618 for a special method of reusing waste paper. The patented method is mainly concerned with the elimination of odors developing in the treatment of waste paper. An untreated waste paper pulp is brought to a certain pH value by mixing it with a buffer substance and subsequently subjected to a heat, and pressure treatment. After a rapid reduction of the pressure, the annoying waste gases above the pulp are sucked off. (Text in German)

68-0991

Kobrin, C. L. Preheating scrap for the BOF. *Iron Age*, 201(3):57-59, Jan. 18, 1968.

The steel industry is exploring several ways to increase the scrap to hot metal ratio in the BOF (basic oxygen furnace). Among methods tried are: superheating of the hot metal; addition of solid fuels such as calcium carbide and silicon carbide; and pre-heating of scrap. This last method is at present attracting the most attention. At Wisconsin Steel, scrap preheat facilities were incorporated in the original BOF plant design, and scrap usage has been increased by about 6 percent. At Pittsburgh Steel, which has been using scrap preheating since December, most heats have been made with 40 percent scrap when making mild steel—an increase of 8 percent over standard practice. Medium carbon heats have been made up with 36 percent scrap (an increase of 7-8%), and high carbon heats with 32 percent scrap (an increase of 7%). Of particular significance were those few low carbon heats in which 50 percent scrap was added. On the other hand, the decrease in hot metal needed per heat means stretching out hot metal capacity, and providing an extra fraction of blast furnace capacity—an attractive feature to steel makers. Scrap preheating practices, for example, already enabled Pittsburgh Steel to get by with only two of its three blast furnaces operating. Descriptions of the preheating process, operational data, and photographs of the steel making equipment are included.

68-0992

Krause, G. Improved method to regain lye from waste lye remaining from the treatment of cellulose containing materials. *Das Papier*, 22(4):L38-L39, Apr. 1968.

The Stora Koppabergs Berglags AB, Falun, Sweden, obtained British patent 1,077,324 on July 26, 1967. The patent was

applied for on Jan. 29, 1965. The Swedish patent was granted Feb. 7, 1964. The patent describes an improved method to recover lye from the waste lye remaining after treatment of cellulose-containing materials. The waste lye used for the regeneration process contains sodium sulfite and/or sodium bisulfite, as well as sodium carbonate and/or sodium bicarbonate. The method includes: evaporating the waste lye; ashing the sulfide or carbon containing solution; regaining the sulphur from the hydrogen sulphide ejected by means of carbon dioxide; oxidation of hydrogen sulphide to sulphur dioxide; and re-use of the sulphur dioxide to prepare fresh lye. The patented improvements concern the ashing and the technology of a carbon dioxide cycle in which carbon dioxide is reused efficiently. (Text in German)

68-0993

Krisnabamrung, W., and N. Takamura. Suitabilities of some Thai hardwoods and coconut fibre for manufacturing hardboards by wet-and-dry processes. *Journal of the Japanese Technical Association of Pulp and Paper Industry*, 22(3):38-48, Mar. 1968.

The results of investigations into the suitabilities of seven Thai hardwoods and coconut fiber as raw materials for hardboards are presented. The fibers were prepared by the Asplund Defibrator process. A phenolic resin (0.5%) and paraffin emulsion were added to fibers in the wet process, and 4 percent of these agents were added in the dry process. Neither heat treatment nor oil tempering were performed in this investigation. Coconut fiber gave outstandingly high board flexibilities, comparable to wood fiber from the wet process. A board from coconut fiber gave rather low strength in static loading, however.

68-0994

Kutera, J. Prospects of development of agricultural utilization of sewage. *Gospodarka Wodna*, 15(1):20-23, Jan. 1968.

The extent of utilization of sewage for irrigation and fertilization in several foreign countries was surveyed. The situation in Poland, where presently about 17,000 ha of land are treated by sewage, is discussed. Utilization of sewage in agriculture guarantees a higher degree of purification than any industrial purification station, and at the same time, increases agricultural yields. The quality of the soil was found suitable for irrigation by sewage. The program and tasks for future agricultural exploitation of waste waters are outlined. (Text in Polish)

68-0995

Lake Balers at J. C. Penney Co. Plant. *Waste Trade Journal* 64(21):18, May 31, 1968.

Over 30 tons per day of scrap corrugated cartons and paper can be baled by two 72-in. automatically cycled Lake Balers in the J. C. Penney Company catalog center. Scrap is fed into shredders which tear the scrap into small pieces and throw it into air streams. From here it is blown into overhead cyclone separators directly over the balers. The separators allow the air to escape, and the scrap falls down through the feed chutes into the baling chambers where it is compressed into 72-in.-long bales by means of horizontal, high pressure rams.

68-0996

Lane, G. H. The case against burning used tires. *Rubber Journal*, 150(2):44, 59, Feb. 1968.

A proposal for burning used tires through the construction of 150 specially designed incinerators, at a cost of £3 million is discussed. The effects on the economy of making it cheaper for garages to burn the tires than to supply retread tire manufacturers, who would not in turn be able to supply rubber reclaim manufacturers, is considered potentially disastrous. A method of processing used tires to produce rubber crumb and rayon and cotton flock, which was developed in Hungary, is described. Called the Palma method, it produces extremely pure rubber crumb (0.5 percent textile content) and uniform samples. Uses for the crumb include mixing the rubber with bitumin to produce improved road and playground surfaces. Uses of the rayon and cotton flock include the manufacture of cheap felt and rug underlays. Considering the products produced by the Palma Machine, (patented worldwide, developed in Hungary) and the after effects of the incineration scheme, the author strongly suggests investigations into the possibilities of the Palma process. Official Hungarian calculations indicate that at an initial cost of £90,000, the machine would pay for itself in two years.

68-0997

Leffel, F. C., A. Kramer, I. Ben Gera, et al. Utilization of waste from tomato and cheese production. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint E-8.)

Wastes from tomato harvesting, processing, and canning are being evaluated by chemical, biological, and nutritional techniques. Chemical analyses of tomato wastes indicate a relatively rich potential source of proteins, pectins, and tomatine. Suitable fermentation (ensiling) can be induced if air is excluded from chopped, compressed tomato waste, especially if moisture is reduced by wilting or by adding dry fibrous materials. Weight gains in tomato-waste-fed lambs were less than on those on the alfalfa control, but the wilted vine silage, the vines and corn cobs, and the cannery waste compared well with corn silage. Preliminary studies were designed to investigate possible usage of both sweet and acid wheys in the production of sherbert, filled and imitation milks, and fermented products. A common protein instability problem has been encountered in all products in which whey solids were used. Protein appeared to increase as the heating temperatures increased.

68-0998

Levine, S. Regenerated lime—the quiet boom. *Rock Products*, 71(7):54-60, July 1968.

A large amount of the lime produced in the United States is derived from individual by-products or wastes. About 23 percent of the 17.2 million tons of quicklime sold or used by producers in 1966 came from regeneration of lime from calcium carbonate and hydroxide sludges and slurries. Lime is reclaimed by calcination of calcium carbonate sludges in pulp and paper mills, beet sugar plants, and municipal water treatment facilities. Sewage treatment processes,

incorporating a lime regeneration step, have been developed. Increasing emphasis is being placed on spent lime reclamation for anti-pollution as well as economic reasons. Phosphate removal from sewage is being required by an increasing number of State regulatory agencies. Rotary kilns, fluidized-bed kilns, regeneration kilns, and multiple hearth kilns are discussed.

68-0999

Lonergan, R. P., and E. M. Herson. Solid waste—a natural resource? In E. Flack, and M. C. Shipley, eds. *9th Western Resources Conference Book 1967: Man and the Quality of His Environment*, Boulder, University of Colorado Press, 1968. p.107-120.

The terms pollutants, resources, and wastes are defined. If unwanted goods can be returned economically to the economic cycle, costs of industrial goods and waste treatment operations can be lowered, and at the same time, natural resources can be conserved. The discarded automobile could be recycled if feasible and economical methods were developed to salvage its major components. If organic wastes could be utilized, they could possibly supply much of man's needs, including food, medicine, organic chemicals, heat, fertilizer, soil conditioning materials, and reclaimed land. The salvage of raw glass, paper, and tin cans from household refuse has steadily decreased in the United States. There has also been a decrease in the use of scrap because of the steel industry's demand for a product with higher purity. Three solid waste disposal methods are reviewed: sanitary landfill, incineration with final disposal in a sanitary landfill, and composting. Funds were appropriated under the Solid Waste Disposal Act of 1965 in the form of grants of four types: research, planning, training, and demonstrations. Demonstration and research grant projects, already funded by the program, are described.

68-1000

Lund, R. E., G. E. Welch, J. Ferrighetto, and B. E. Hoffacker. St. Joe reclaims zinc with heavy media separation. *Mining Engineering*, 20(12):81-84, Dec. 1968.

The Josephstown Smelter of St. Joseph Lead Company applies the Heavy Media Separation process to reclaim zinc and reject gangue from electrothermic zinc furnace residues. The semi-dry residue consists of partially-smelted sinter, coke particles, fused slag, and globules of ferrosilicon. Research investigations, plant design, and operating experiences are described. About 7,500 tons of zinc from 125,000 tons of previously discarded slag was recovered. About 93 tons per month of zinc are recovered from residue. There are also savings in sintering and furnace costs gained from decreasing the quantity of gangue reported in the recirculated residue.

68-1001

Magnetic separation for 'mining' scrap heaps. *Materials Reclamation Weekly*, 113(7):23, Aug. 17, 1968.

Magnets are now being used for the separation and recovery of valuable ferrous scrap metals. In the United Kingdom, it has been estimated that 14 million tons per year of refuse is dumped, with a potential value of £ 22 per million. Hove

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Corporation, employing electrical magnets to lift out all cans and other ferrous metals from its scrap heaps, reclaims all but 5 tons of the 450 tons per week handled by its salvage department. Non-magnetic, non-ferrous metals are picked out by hand, and the value of the reclaimed scrap largely offsets the cost of its refuse collection service. Eriez Magnetics has installed special equipment in its Central Test Laboratory to conduct complete tests of the separation and recovery of ferrous scrap from non-ferrous materials, such as pulverized car bodies and other forms of shredded scrap. The tests, carried out on a fee basis, determine the most efficient means of separation and which type and size of equipment will do the best job.

68-1002

Majumdar, K. K. Utilization of waste mica for the production of building materials. *Research and Industry*, 13(2):77-78, Apr.-June 1968.

The possibility of replacing asbestos-based building and insulating materials by materials prepared from ground mica-cement mixes is examined, with the object of finding economic means of utilizing the vast quantities of waste mica available at various mica mines in India. Slabs, prepared from mixtures of ground mica (preferable particle size 60 Tyler mesh) with portland cement in different proportions, after suitable curing treatment, have been found to possess bulk density, tensile strength, and conductivity characteristics comparable to those of asbestos-cement slabs. Results are tabulated and presented.

68-1003

Making mine dumps bloom. *Coal, Gold, and Base Minerals of Southern Africa*, 16(7):28-34, Sept. 1968.

High acidity and lack of nutrients are the main problems associated with planting on mine dumps to prevent dust. The acidity of the area is reduced by liming. A seed mixture of grasses, trees, and other vegetation is sown, and then supplemented by the introduction of plants not readily raised from seeds. The annual grasses, which grow quickly, protect, and provide humus for slower growing plants which form the basis of a permanent cover. The commercial varieties of plants selected were: two varieties of acacia, weeping love grass, Kentucky blue, redtop, and Rhodes grass. Clover, lucerne, and other legumes were also included. The cover is intended to eliminate dust and to prevent the pollution of water courses by mine sand and slime washed down during rain storms.

68-1004

Mantle, E. C., and N. H. Jackson. The reclamation of scrap. *Copper*, 2(1):6-8, Jan. 1968.

The importance of segregating scrap at the source and accurate sorting by scrap merchants is emphasized, since the refining operation involves loss of the metal in slag and fumes. Most scrap copper and copper-base metals in Great Britain are reused and a simple, relatively cheap method of accurately identifying scrap components is needed. The avoidance of air pollution in the reclamation of certain kinds of copper-base scrap often requires sophisticated cleaning

devices. Development of a computer system for determining the best charge for a particular furnace from the various scraps available promised reduction in costs ranging from 1 to 10 percent.

68-1005

Marenkin, F. Sewage must bring good, not ill. *Journal of Environmental Health*, 31(1): 53-54, July-Aug. 1968.

In the Soviet Union, industrial and domestic sewage is being utilized in all-year-round agricultural sewage farms. Large tracts are used employing modern agricultural irrigation techniques. There is no odor of decomposing organic matter. Sewage is transported by means of closed pipes, buried in the earth to a depth of 70 to 80 cm. Raised outflow hydrants are installed at key points along the pipelines from which sewage is obtained for irrigation. In the fall-winter period, sewage is used for irrigation of fruiting berries, arboreal plantings, permanent haying and pasture; in the growing season, for irrigation of vegetables, cereals, and potatoes. The Noginski State Farm, just below Moscow, uses domestic wastes and wastes from two textile enterprises. Harmful ingredients are in concentrations which do not have detrimental effects. Utilization of sewage in agriculture has effected a rise in crop yields, and provided an inexpensive method of purifying sewage.

68-1006

McDonald, P. This land is your land—this land is my land. *Scrap Age*, 25(11):73, 83, 85, Nov. 1968.

The problems of air, water, and land pollution, and the technical services offered by the Solid Wastes Program of the Public Health Service, are discussed. Associations representing metal finishing, paint, and forest products industries have joined in research projects to combat pollution. Project Green/Screen, sponsored by the Institute of Scrap Iron and Steel, proved that planning and imagination can turn industrial plants into aesthetically acceptable operations. The iron and steel reclamation industry, which as a part of its normal daily business works against polluting the land, is examined in detail. The use of 1 ton of processed scrap replaces, and consequently preserves 1½ tons of iron ore, 1 ton of coke, and ½ ton of limestone in the steelmaking process. The ferrous metals reclamation industry produced in excess of 35 million tons of valuable metals in 1967 for reuse. Two reforms needed to extend the use and reuse of valuable materials are to design mineral-containing products to last longer before they go out of style or wear out, and to design products to make it easier to collect and separate their mineral content for recycling after they are discarded. It is estimated that industries such as the scrap processing industry contributed to the total air pollution problem of less than 2 percent.

68-1007

Method to improve the regaining of fiber from waste water of the paper, cardboard and cellulose industry. *Das Papier*, 22(4):208, Apr. 1968.

Farbwerke Hoechst AG, Frankfurt, Germany, applied for a German patent for a method to improve the reclamation of

fiber from the waste water of the paper, cardboard, and cellulose industry. The inventors, Hans Sommer, Herbert Bestian, and Dieter Bergmann, applied for the patent on Mar. 14, 1964. (Text in German)

68-1008

Method to re-use waste paper. *Das Papier*, 22 (4):208, Apr. 1968.

A German patent was granted to the Battelle Institute, Frankfurt, Germany, for a method to re-use waste paper. The inventor Dieter Wenzel, 5160 Dueren, Germany, applied for the patent on Mar. 31, 1961, and obtained it on Aug. 3, 1967. (Text in German)

68-1009

Milwaukee briquetter shows new ways to up-grade scrap turnings-borings-chips. *Waste Trade Journal*, 64(16):44, Apr. 27, 1968.

Scrap processing firms are turning to briquetting as a way of bulk reduction to produce and ship a product uniform in density and size. If briquettes of cast iron borings or crushed steel turnings are formed with a density of 60 to 70 percent, there would be a weight gain per cu ft of 100 to 200 percent. Briquettes are easier to handle, store, and charge into melting equipment. Commonly briquetted materials are crushed steel turnings, cast iron borings, aluminum, bronze, brass and copper chips, and properly prepared stainless steel and other alloys.

68-1010

Modell, M. Appendix D. Research possibilities in the hydrogenation of paper. In *Summer study on the management of solid wastes*; final report. v.1. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968, p.38-39.

The long-range problem of recovering economic value from the cellulosic component of solid waste is discussed. The problem is to convert paper into a product which is durable, or is consumed and converted to non-solid waste products. The burning of paper followed by recovery of the waste heat is a process which is efficient only on a very large scale, but the operation is relatively expensive. Two basic approaches are introduced: separate the paper and briquette it for use as a coal substitute in coal-fired plants; or liquify it for use as a heating oil for power plant or home use. The first approach is straightforward; the second is a relatively new idea. The economics of complete hydrogenation of cellulose is presented. Complete hydrogenation does not appear to be economically attractive because hydrogen is an expensive chemical. What happens to cellulose under conditions of partial hydrogenation could be important, however.

68-1011

Modern scrap iron handling methods used by Japan steel mills. *Waste Trade Journal*, 64 (9):34, Feb. 29, 1968.

Japanese steel makers produced over 62 million tons of steel in 1967, and they predict an 80 million ton per year output

by the end of the decade. Coastal plants remove one phase of transportation costs by bringing the ore beds and coal stockpiles plus the blast furnace and coke ovens right to the unloading dock. Tremendous strides have been made in unloading facilities and belt conveyor systems. The cost of scrap is \$45 to \$50 per ton, and this explains Japan's position as leader in the field of blast furnace technology. The advent of the oxygen converter and the large number of graduate engineers working in steel mills are prime factors in Japan's rise as a steel giant.

68-1012

Multi-purpose shredder. *Waste Trade World*, 112(3):12-13, Jan. 20, 1968.

A shredder in a waste paper plant is being used to convert materials, ranging from 12-in.-diameter reel centers to kraft sacks, into shreds. The effectiveness of a horizontal baling press is enhanced as a result of shredding; the bales are more dense and will withstand re-handling to a far greater extent than non-shredded bales. This factor becomes highly significant when applied to economic and profitable exporting of waste paper.

68-1013

New machine solves detinning problem. *Materials Reclamation Weekly*, 113(2):33, July 13, 1968.

A high-speed disintegrator which shreds steel strip has two primary uses: to prepare coated metals, such as tinplate, for reclamation, and to reduce scrap or reject metal to a more easily handled form. The problem of preparing tinplate for detinning requires a way for the detinning fluid to circulate over the surface. The metal cannot be remelted as scrap without removing the tin, and the tin cannot be economically salvaged while the metal is in roll form. Tinplate rolls are fed into the machine where they are torn into pieces 2½ in. wide by 5 in. to 10 in. long, and deformed, making the metal surface ideal for detinning. The tin is then reclaimed, and the metal is baled and sold as top grade scrap metal. The machine can handle metal ranging from 0.004 in. to 0.032 in. in thickness, and 300 ft. per minute of the lighter metal in sheets or strips up to 48 in. wide. It may be roll or sheet fed. The plant will disintegrate approximately 21 tons per hr of the 0.032 in. metal when operating at 150 ft. per minute, and slightly less of the lighter metal at 300 ft. per minute.

68-1014

New paper press for Birkenhead. *Public Cleansing*, 58(1):12-13, Jan. 1968.

A 'Hindel' Horizontal Baling Press was installed to replace the existing press dealing with mixed waste paper. The bales produced from the press measure 36 in. by 26 in. by 54 in. long, weighing between 5½ and 6½ cwt. Since the press was commissioned, the total mixed waste paper output has increased by 50 percent. It is felt that the press has resulted in considerable labour savings in the baling section, and the machine is producing heavier, denser bales, solving many problems in storage, loading, and transportation. The heavier bales attract a higher price at the board mills, and the whole operation of baling is virtually dust free.

Recycling

68-1015

New refuse-to-fertilizer process. *Chemical Processing*, 14(3):20-21, Mar. 1968.

A process for making household garbage into a clean, cheap, effective fertilizer to be called Sweetsoil, has been developed. All material including bulky objects such as bicycle frames, rolls of old carpet, old furniture, as well as all forms of domestic, shop, office, and other refuse including that with a paper content of as high as 80 percent is accepted. A plant with a rated throughput of 100 tons per day will accept refuse at the rate of 50 tons per hr directly into the primary shredder, which reduces the lot to pieces 6 to 8 in. long. These are conveyed to a digester, where water and air are metered automatically under precisely controlled conditions. The refuse is digested for about 5 days. Each digester has an input rating of 25 tons per day. In the digester, heat produced by natural bacterial action raises the temperature of the mass to 160 F which destroys all harmful micro-organisms. The digested refuse is then passed through a separation process which removes ferrous materials and large inert fragments such as pieces of tire. A powerful high speed grinder then reduces all glass to a harmless powder and removes lumps. The separated material may be used for sanitary landfill and may amount to 20 percent by weight, or 10 percent by volume of the total plant input. The fertilizer may be of three types: Origin, without added chemicals, as a soil conditioner; a chemically supplemented fertilizer for lawns, etc.; and a heavily chemically supplemented product for commercial use. To serve a population of 100,000, a plant would cost approximately \$350,000 including building and foundation. Such a plant would produce 300 tons per week of fertilizer. At an ex-plant cost of \$10 per ton this would yield \$150,000 per year. Four of these plants have been ordered for St. Louis, Missouri.

68-1016

New wastepaper depot at Hyde. *Public Cleansing*, 58(7):321-322, July 1968.

A new sanitary landfill site for Hyde Borough, England, and a depot for receiving and handling wastepaper, is described. A building 75 ft long and 45 ft wide, with a maximum height of 21 ft, has been erected. The three-level depot consists of: a wastepaper receiving floor, a baling floor and bale storage below the receiving floor, and external loading bay for bales dispatch, employee facilities, and garage space. Salvage trailers and vehicles use a road located around the depot, and discharge wastepaper on the receiving floor at the higher level. The paper is raked onto a conveyor, sorted, and discharged into the filling box of the swivel-box type press which is 9 ft below the receiving floor level. A dust extraction fan, and two intake ducts will be fitted at the head of the conveyor. Bale handling has been facilitated by rollers in the floor of the swivel-box, and a roller platform on a four-wheel truck, which is used for conveying the bale onto 1 ft high settling blocks on the storage floor. Bale loading onto the dispatch vehicle is by a manually operated 1-ton hoisting and traveling pulley on the cantilever of the steel gantry, over the external loading bay.

68-1017

Nierychlewski, T., and A. Winczakiewicz. On the utilization of old paper in fabricating corrugated cardboard. *La Papeterie*, 90(1): 24-33, Jan. 1961.

Recently much attention has been given to the utilization of old paper as raw material for corrugated cardboard. Research included the problems of material choice and specific weight in the case of multilayer cardboards, and the problems of fabrication technologies. Tests were performed both with industrially fabricated and laboratory samples of cardboard consisting mostly of old paper used in the corrugated and covering layers. Such cardboard has shown inferior resistance properties in comparison to those which were manufactured from first-class raw materials (e.g. sulfite or semi-chemical pulps); nevertheless, they have justified their production in terms of the fabrication of light and cheap packages fully satisfying the local transport requirements of light merchandise (e.g. shoes, textiles, small electrical appliances, etc.). The price of corrugated cardboard from old paper is 50 to 60 percent lower than that of cardboard from first-rate materials. (Text in French)

68-1018

Paper from bagasse. *World's Paper Trade Review*, 170(10):528-538, Sept. 1968.

Basically, the process of making paper from bagasse (developed for use in Paramonga, Peru) consists of removing the pith from the fibers by milling, screening, and then pulping according to standard methods in rotary or continuous digesters, blow tanks, vacuum washers, screens, and thickeners. The fibers are digested by means of a modified soda process, the quantity of caustic soda varying according to the quality of the depithed bagasse and the type of pulp to be processed. For fine quality papers the pulp is bleached by a three-step process using liquid chlorine, caustic soda, and hypochlorite. Using the patented PFADCO continuous cooking process, which produces pulps suitable for use in all grades of paper and paperboards, the depithed fiber is the same in all cases with the pulp grade dependent upon time, temperature, and chemical relationships. Cooking caustic ranges from 8 to 26 percent on finished pulp, while steam usage varies from 1 to 1.5 lb per lb of bone dry pulp. The cooking cycle varies from 10 to 20 minutes, and the liquors per BD fiber ratio is below 2 to 1. Under properly controlled conditions, pulp yields are high and of uniform quality. Normally, the bagasse pulp is passed through a high-density refiner to brush out and disperse the fiber mass prior to washing on a multi-stage countercurrent washer. After washing, the pulp is screened, with the rejects being recycled to the digesters to minimize fiber losses.

68-1019

Pashelensky, B. Upgrading nickel scrap for alloy users. *Waste Trade Journal*, 64(16): 23-24, Apr. 27, 1968.

Secondary nickel and nickel alloy scrap, its relation to the consumer market, and its place in the metallurgical revolution which has taken place in the last 10 years is considered. Many super alloys, exotic alloys, and high temperature alloys, which are required for space age use, are available, and the resulting scrap must be handled and identified. Secondary alloys are an important source for alloy mills for their raw material requirements. Their major interest is for the production of 18/8 stainless steel and under normal conditions they are willing to pay only \$40 or \$50 per ton below the cost of the primary metal. Investment casting foundries, and/or high temperature exotic alloy mills, have

extremely rigid requirements. The special metal processing firms, whose function is to identify and physically process scrap to meet the foundries' needs and specifications, can handle the small lot alloys at a relatively modest return considering the problems involved. The secondary nickel alloy smelters consume those alloys of high nickel and/or cobalt content, whose condition makes them undesirable for the alloy mills.

68-1020

Pilny, F. The question of harmfulness of glass parts in sintered slag from waste incineration used as additive in concrete production. *Glastechnische Berichte*, 41(3):97, Mar. 1968.

An investigation was conducted to determine if glass in waste whose slag is used in concrete production is harmful to the strength of the concrete. Concrete bars (weight 12 kg) containing 500 g of glass splinters were used. The first expansion was observed after 20 months, which increased to 5.3 percent by the end of the test. The measurements were performed at plugs inserted into the bars on one side only, so that a distortion might be included in the obtained data. After 120 months the rigidity fell from 56.5 kp per sq cm to 22 kp per sq cm, and the resistance to pressure from 512 to 310 kp per sq cm. The question now arose as to how the results of tests performed on samples with relatively large glass splinters relate to a concrete made with sintered slag from waste where the glass parts were smelted with the rest of the waste. The waste department of Berlin examined the total waste for the amount of glass. It amounted to 9.8 percent of the waste in the year 1963-6.8 percent in the form of bottles and 3 percent in the form of glass splinters. This rather low percentage of glass in the waste is considered bearable, especially when the high temperatures during incineration (1,900 C) and sintering (1,200 to 1,300 C) are considered. In sintered slag grains, only white ceramic intrusions were found, and the glass parts were no longer visible. After a brief experience with waste slag concrete, no harmful effects of the glass in the slag have been observed. (Text in German)

68-1021

Pohle, R. Incineration of raw tar as additional fuel in a steam generator. *Gas und Wasserfach, Wasser, Abwasser*, 109(19):517-519, May 1968.

The demand for raw tar which accumulates in coking plants shows a downward trend. Prices are so low that its use as an additional fuel can be considered. It has been used in a vertical tube boiler of a remote heat supply plant. The raw tar has a viscosity of about 4.6 degrees E at 50 C, and of 1.8 degrees E at 75 C. The lower heating value is 8,900 kcal per kg at a water content of 2.5 percent. The specific weight is 1.05 to 1.1 ton per cu m. The vertical tube boiler has a capacity of 64 tons of steam per hr at 500 C and 80 atm. An illustration of the boiler is given. At each side of the vertical tube boiler is a burner fed with a mixture of tar and steam. In order to incinerate the raw tar, it is atomized to fine droplets with steam. The amount of raw tar and the pressure with which it is injected can be regulated. The droplets flow through an inner tube to the nozzle where they are again mixed with atomized steam. A vane in the nozzle gives the raw tar steam mist a rotary impulse towards the flame

chamber. The mist burns with a short hot flame to avoid corrosion. The burners have so far operated satisfactorily. In the years 1964 to 1966, 16,280 tons of raw tar were burned. The costs saved by the use of this waste material, instead of another fuel, have been calculated at 0.0096 DM per M cal, which is more profitable than selling it, since the market price is 0.0079 DM. (Text in German)

68-1022

Prandi, M. E. New aspects of utilizing blast-furnace granular slag in road construction. *Annales de l'Institut Technique du Batiment et des Travaux Publics*, 21(242):211-232, Feb. 1968.

Gravel-slugs and sand-slugs are defined as mixtures made in the plant with a high proportion of freshly made granular slag activated by a basal catalyzer. Gravel-slugs are compared to untreated gravels and gravel-cements. The properties of gravel-slugs for roadbeds which are stressed are: homogeneity due to a high proportion of binder, a good grain size and, angularity of the basic granulates, a high insensitivity to excess water or to frost, a very slow setting in the early stages, and a progressive hardening which avoids any disparity between the rigidity of the old and new pavement. A review is given of the various parameters that influence the compressive and tensile strengths of the gravel-slugs and sand-slugs, e.g. batching and quality of the granular slag, mineralogical nature and granularity of the granulates, batching and quality of the base catalyzer, time and temperature of curing of test pieces, density and intensity of compacting. Particular emphasis is given to two essential qualities of the roadbeds: homogeneity and compactness. The conditions required in order to guarantee that the gravel-slugs will have good qualities are described in detail. (Text in French)

68-1023

Proceedings, First Mineral Waste Utilization Symposium, Chicago, Mar. 27-28, 1968. U.S. Bureau of Mines, and Illinois Institute of Technology Research Institute. 154 p.

This symposium concentrated on the utilization of industrial wastes, particularly industrial wastes from mining. The keynote address dealt with man-made ores—that is, recycled or reclaimed solid waste materials in general. Specific topics included: the handling, processing, and marketing of steel-making slag; utilization of foundry waste by-products; fly ash and incinerator residue utilization; waste occurring in the ceramic industry; ferrous scrap recycling; and non-ferrous scrap recycling, the non-ferrous materials including gold, copper, aluminum, lead, zinc, and nickel wastes plus phosphate and coal wastes. Supplementary papers dealt with mineral waste utilization in Europe, utilization of slurry pipes in industry, and reclamation of calcium silicate to create building materials.

68-1024

Process recovers byproducts from refinery waste-streams. *Chemical Engineering*, 75(11): 88, May 20, 1968.

A process has been developed for the recovery of ammonia and hydrogen sulfide from refinery waste streams. The process recovers ammonia as either a high-purity anhydrous

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liquid, or as an aqueous solution. The hydrogen sulfide is 99.9 percent pure and can be fed directly to a sulfuric acid plant. Effluent from the refinery units normally contain 3 to 5 percent contaminants, and a unit processing 135 gal per minute of waste water containing 4 percent ammonium sulfide would cost about \$600,000. The higher the concentration of contaminants, the more economical the process. The 'clean' water remaining after the recovery is reused. Previously, the waste stream had to be burned. The process has been so successful at one refinery that it has paid for itself in a year, and it is now earning a profit from the by-products.

68-1025

Radio controlled scrap baler speeds operation at Continental Steel. Iron and Steel Engineer, 45(4):136, Apr. 1968.

A large, radio controlled, scrap baling press has been performing satisfactorily for the past year at a Kokomo, Indiana, steel plant. The system, has been designed to direct operation of a huge Harris TG-1202 hydraulic baler. With a compression factor of 2700 psi, the baler has little difficulty reducing a variety of home scrap, as well as entire auto bodies, into bales sized for charging into electric steelmaking furnaces.

68-1026

Reclamation industry 'more important than ever'. Waste Trade World, 112(13):4-5, Mar. 30, 1968.

At a symposium on solid wastes sponsored by the Gulf South Research Institute, M. J. Mighdoll, of the National Association of Secondary Material Industries, said that the problem of air pollution has become critical. The NASMI is helping its members by conducting studies in air pollution control. A joint research project with the Department of Health, Education, and Welfare is being sought on the particular problem of zinc chloride emission.

68-1027

Remirez, R. Gypsum finds new role in easing sulfur shortage. Chemical Engineering, 75 (24):112-114, Nov. 4, 1968.

A process, developed by Österreichische Stickstoffwerke Aktiengesellschaft (OSW) at Linz, Austria, uses either waste gypsum, natural gypsum, or anhydrite to make sulfuric acid and cement. The technology is based on the Muller-Kuhne reactions: gypsum (plus clinker materials) is converted to sulfur dioxide and cement by roasting. The roaster gas is then fed into a conventional contact unit for conversion to sulfuric acid of 98 percent strength. At Linz, the raw materials—anhydrite, fly ash, sand, and coke—are ground separately to the proper fineness, stored, and then fed to a blender for thorough mixing before being fed into the kiln. Clinker is cooled and stored for subsequent mixing with gypsum and then grinding into cement for sale. The technical performance of the kiln hinges on: keeping the specific atmospheres of the various zones of the kiln within narrow limits to ensure reduction of calcium sulfate by the coke; and keeping the feed composition within a narrow range so that the right proportions of carbon-calcium sulfate and lime are available for the formation of clinker material.

68-1028

Report on Taiwan Sugar Congress by ASPA delegate. Australian Sugar Journal, 60(4):217, 219-220, July 1968.

The extent to which the utilization of by-products of the Taiwan sugar industry has been developed is stated in a report on the 13th I.S.S.C.T. Congress held in Taiwan, March 1968. By-product development has been stimulated by the large population, the short distances of transport, and a shortage of foreign exchange, which has made it necessary to curtail imports and promote exports. Sugar mill by-products, such as molasses and yeast, are fed to pigs, and the barn manure from the pigs is composted with bagasse to fertilize the sugar cane in the field. For the preparation of compost, bagasse is mixed with the manure in the proportion of 1 to 3 by weight. Bagasse is also used in the manufacture of pulp and paper, hardboard, insulation board, and particle board.

68-1029

Re-use of shavings and drillings from iron and steel processing. Chemie-Ingenieur-Technik, 40(8):A489, Apr. 1968.

Metal shavings, etc., from machinery usually sold as scrap can be re-used if processed into briquettes by a method invented in the United States. They are heated to 980 C and at that temperature become viscous and adhesive, so that no binding material is required for briquetting. The oil which covers the shavings serves as fuel to heat the drillings. To preheat them, the shavings are mixed with finished hot briquettes, then separated and loaded into an oven where temperatures are between 815 and 1,093 C. The essential part of the plant (developed by the Komerak-Greaves & Co., Rosemont, Illinois), is the briquetting machine, whose rollers are made of a high quality steel alloy to withstand the extreme operating conditions (982 C, 70 kg per sq mm). The steel alloy has a Rockwell hardness between 57 and 65. The main advantage gained through briquetting is a reduction of volume to one fortieth of the loose material. The cost saved by the fact that no binder is required is more than the cost involved in the heating up process. This briquetting process, which was originally developed for the treatment of fly ash and coal dust, was first tried on iron and steel drillings in an iron foundry in the Chevrolet plant in Tonawanda, New York. Further applications of this method, e.g. with bauxite, fertilizer, plastic material, are planned. A diagram illustrating the briquetting process is given. (Text in German)

68-1030

Reynolds, D. P. Recycling of aluminum: one answer to litter and conservation challenges. Reynolds Review, p.8-9, Nov.-Dec. 1968.

It is economically feasible to recycle aluminum at present prices (a ton of aluminum will bring \$200 from dealers compared with \$20 for steel and \$16 for waste paper). Reynolds Metal Co. has been studying various approaches to recycling aluminum to eliminate waste and litter. Can-reclamation programs are in effect in Miami, Los Angeles, and other cities. Aluminum reclamation programs and a recycling system may be built into the industrial and economic structure, thus greatly reducing the solid waste disposal problem.

68-1031

Reynolds, W. F. The Bureau of Mines looks at refuse disposal and recovery possibilities. *Public Works*, 99(12):85-86, Dec. 1968.

Scientists of the Department of the Interior's Bureau of Mines Solid Waste Research Program are centering their attention on three areas: residues from municipal incinerators; tailings from mining processing plants; junk automobiles and other scrap metals. It is estimated that there is about \$1 billion in ferrous and non-ferrous metals reclaimable from dumps and landfills, and about \$7 million in gold and silver recoverable from the fly ash produced by refuse incinerators. A new process has been developed which will reclaim ferrous and non-ferrous metals from municipal incinerators. The waste material is screened, magnetically separated, shredded and ground; fractions rich in metals are then melted and analyzed. By leaching, copper and tin are separated from the iron fractions, producing iron of high quality. Preliminary findings show that municipal refuse contains about 550 lb of metals per ton of residue. About 500 lb of this is iron; the remainder is aluminum, copper, tin and zinc. Examination of the fly ash situation indicates that only about 12 percent is recovered as compared to as much as 65 percent in some countries. Tests show that alumina can be recovered from copper mine waste water for about \$55 per ton. There has been great progress in the development of new types of metal shredders, crushers, and shearers capable of reducing the high cost of processing the handling of scrap autos and other metal scrap. A profitable use of auto scrap metal is the development of scrap-cored lightweight standard size concrete building blocks, which have proved nearly as strong as solid masonry blocks. They are made by molding 2 in. of concrete around compressed auto scrap metal.

68-1032

Rohan, T. M. New maturity eases scrap slump. *Iron Age*, 202(19):63, Nov. 7, 1968.

At the monthly auction of stamping plant scrap by automakers last week, a long standing downtrend on prices finally reversed itself. The guidance of the AISI, of which about 1,150 scrap dealers are members, has helped dealers in this recent slump. New technical research indicates the possibility of using high speed water jets to cut scrap instead of flame cutting. The industry's main efforts are directed toward cost control, freight rates, and cooperation with the national beautification program. Imports of new steel have affected the scrap market and the employment situation is still a problem.

68-1033

Rohrer, E. Fodder produced from waste compost and sewage sludge. *Wasser, Luft und Betrieb*, 2(4):234-235, Apr. 1968.

The incineration of all wastes is not as ideal a solution as one may think, since it leaves ash and slag, which pollute ground water when dumped. If the waste is homogenized and subjected to rotting, however, a product is obtained which can be dumped anywhere without being hazardous to water and air. The composting of waste is even better, because a valuable product is obtained which can be sold. The non-putrescible material in the waste (plastic, metals, textiles

etc.) must be separated before composting. A low-priced thermal insulating material for the construction industry can be made from this material. Waste compost is not a very valuable fertilizer as the mean values of 12 monthly samples (without sludge) from the plant in Buchs, Switzerland show: 52.2 percent inert material; 1.08 percent nitrogen; 1.33 percent magnesia; 1.20 percent phosphate; and 0.31 percent potash. The various amino acids found in compost samples are listed. A number of trace elements were found, as well as auxins which stimulate plant growth. In spite of a certain value as a fertilizer, the compost mainly improves the physical characteristics of the soil. The quality of waste compost can be improved by adding sewage sludge. The composition of sludge samples taken in Berlin and Buchs, Switzerland, is listed in tables. A comparison of the amino acid contents of pure waste compost with those of dried activated sludge shows the higher quality of sludge. But as good as waste-sludge compost may be, it very often is difficult to sell. Therefore, experiments have been carried out to use waste-sludge compost as fodder. Various animals were fed it with good results. Dutch feedings of waste compost to young pigs showed that this material contains iron which can be especially well absorbed. This method of using waste compost and sludge leaves no by-products and covers production costs. (Text in German)

68-1034

Rosenbaum, J. B., and K. C. Dean. Utilization and stabilization of solid mineral wastes. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint No. C-13.)

Some of the Bureau of Mines research is concerned with both the utilization and the stabilization of metallic and nonmetallic mine, mill, and smelter wastes obtained from 40 different mineral waste accumulations. Utilization studies cover flue dust generated in foundries using automotive iron scrap, copper cementation using shredded automobile scrap, flotation mill tailings from porphyry copper ore concentrators, and dismantling of scrapped automobiles. Methods of stabilization include: massive coverings of coarse slag, concrete, and soil to bond particles of fine-size waste; chemical stabilization by reacting the waste pile surface with a reagent to form a water and wind resistant crust; and vegetative stabilization by seeding in waste materials which have been adequately prepared. A combination chemical-vegetative stabilization method has several advantages. A planting of vegetation stabilized by coating with Cohorex, a resinous emulsion, will soon be evaluated.

68-1035

Rosenson, R. Silver the critical metal. *Waste Trade Journal*, 64(9):40-41, Feb. 29, 1968.

In view of the critical shortage of silver, industries and institutions which generate precious metals are examined: electronic components, platers, aircraft, chemical, communications, and hospitals. Plastic, ceramic, and iron materials may have precious metal value. The presence of iron, nickel, stainless steel, molybdenum, and tungsten does not interfere as much with precious metal recovery as does aluminum. More silver clad products such as contact points, circuitry, and relays are expected in the future.

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68-1036

Scherfig, J., C. F. Reid, and E. A. Pearson. Determination of low levels of extractable organic acids in sludge digesters. *Water and Sewage Works*, 115(7):316-319, July 1968.

A proposed modification of the extraction method for determining volatile fatty acids, as outlined in Standard Methods, is described. The modification extends the lower limit of the procedure from 200 mg per liter to 30 mg per liter as acetic acid. It is shown that neither the standard method, nor this modification, is specific for volatile fatty acids. The extraction method is satisfactory only for samples containing about 3 milliequivalent per liter of extractable acids. Since concentrations below 3 milliequivalent per liter are common in municipal digesters, this has necessitated the continued use of the time-consuming distillation method. Increased accuracy of the titration method in the low concentration range is possible by using a microburette, a small suction flask, and by titrating under fluorescent light. The needed apparatus and reagents, and the procedure are given. The results, as tested on samples to which a mixture of acetate and propionate were added, are tabulated. Several observations and possible sources of error are identified. It is concluded that: the coefficient of variation is about 2 percent for digester samples containing between 0.5 milliequivalents per liter and 1.0 milliequivalents per liter; the recovery of formic, acetic, and propionic acid in solution is between 92 percent and 103 percent; acids other than the lower fatty acids are also extracted when present; and lactic acid recoveries were approximately 60 percent which increased to 80 percent if 100 ml of butanol-chloroform were used for extraction.

68-1037

Scrap shear and shaker/stacker conveyor. *Metallurgia*, 78(467):103-104, Sept. 1968.

The Sheppard-Harris model BSH-553-3 hydraulic scrap shearing machine is designed to process scrap by compressing both horizontally to a maximum width of 32 in and vertically to a minimum depth of 2 in. In operation, scrap is charged into the open compression box, which is manually operated, to compress and confine the scrap. The feed ram positions the charge for the first cut, and the shear is put in the automatic mode. The clamp/crosshead compresses the scrap; the crosshead makes the shearing stroke; the crosshead and clamp retract; and the feed ram moves forward to feed a preadjusted length of scrap. A shaker conveyor, normally fitted in front of the shear throat, efficiently separates dirt from the sheared material.

68-1038

Secondary fiber users hold first annual conference. *Paper Trade Journal*, 152(45):76, Nov. 4, 1968.

Technical sessions at the Secondary Fiber Pulping Conference, held in Dayton, Ohio, on October 23 to 25, were devoted to: sludge treatment, recovery and re-use of effluent in the mill, and utilization of sludge. Successful cases of combined treatment of municipal sewage and industrial waste included the Battle Creek (Michigan) Wastewater Treatment Plant, the City of Kalamazoo (Michigan) plant, and the proposed plan of the Miami (Ohio) Conservancy District.

68-1039

Soentgen, E. J. The changing world of metals. *Waste Trade Journal*, 64(16):13-15, Apr. 27, 1968.

The nature of scrap has changed considerably, and segregation of scrap by type and alloy is an increasingly important function of scrap handling. The life cycle of aluminum is about 22 years, and of the total aluminum consumed today, approximately 65 percent may eventually reach the secondary market. Old scrap, including remelted scrap ingots, accounts for about 25 percent of the total amount of domestic scrap consumed in the United States. New scrap, generated in the production, fabrication, and use of aluminum in manufacturing is of two types: that which is recycled, and that which is sold in the secondary market place instead of being recycled. Secondary smelters consume something over 70 percent of the marketed scrap. For the remaining 30 percent of the market scrap, foundries and nonintegrated aluminum fabricators consume about 18 percent. Primary producers consume the balance. In general, aluminum shipments tend to grow about twice as fast as the U.S. economy. If this is applied to the G.N.P. through 1975, a growth rate of 6 to 8 percent annually can be expected. Aluminum serves in seven broad market categories: building products, transportation, electrical, aerospace and defense, consumer durables, packaging, machinery and equipment. An increasing percentage of the scrap aluminum will be contaminated by coatings and laminations. These changes in aluminum supply and demand will create changes in the secondary aluminum scrap market; and, with less and less wastage occurring in the primary producers, less new scrap will be around.

68-1040

Stone, R. Efficiency in yard layouts: the shredder presents a problem. *Waste Trade Journal*, 64(9):29, Feb. 29, 1968.

Where hand processing of scrap is necessary prior to machine processing, an adequate area should be provided so that these operations are performed under suitable shelter. The major pieces of scrap processing equipment should be located so that their output may be directly loaded into shipment vehicles. Each crane should have maximum flexibility in the number of areas it can serve and functions it can accomplish. There is a trend favoring the use of a shredder, particularly for yards located within reasonable transporting distance of a steelmaker utilizing electric furnaces. Reduced labor costs and improved personnel safety are also important benefits of shredders.

68-1041

Story, W. S. Ferrous scrap re-cycling. In *Proceedings: First Mineral Waste Utilization Symposium*, Chicago, Mar. 27-28 1968. U.S. Bureau of Mines, and Illinois Institute of Technology Research Institute, p.113-116.

The major uses of iron and steel scrap are the making of pig iron, the production of molten steel, and the output of foundry products. Ferrous scrap is categorized as revert, purchased, or industrial scrap. Most automotive plants have their own scrap processing equipment. In other industries, the material moves to the broker or to the scrap processor yard for baling, shearing, or torching. Major factors in the

scrap cycle are peddlers, autowreckers, junk yards, shipwreckers, and building demolishers. Government installations also provide a large tonnage of scrap each year. The year 1966 saw the highest revert and purchased scrap consumption in the history of the scrap industries—91.5 million tons. However, only 36 million tons were purchased scrap, which is being consumed less and less by the integrated steel mills due to the advent of the basic oxygen furnace in steelmaking. The hydraulic guillotine shear and the shredder or fragmentizer are bringing the industry closer to providing scrap from a heterogeneous source like an automobile.

68-1042

Suchowski, K. Scrap recovery in asbestos cement products plants. *Asbestos*, 49(9):4, 6, 8, Mar. 1968.

Scrap resulting from improper processing and breakage of finished products may reach significant amounts in a large operation, making the reduction of the scrap to granular form, and its re-introduction into the processing operation economical. A two-stage reduction process is generally used because the size of feed varies widely, and heavy duty machines are required. A conveyor introduces the material into the primary crusher which produces particles not more than 30 mm, which are then fed by conveyor to a secondary crusher. Magnetic separation of iron bearing particles is necessary. The fully crushed material is precipitated in a cyclone, and the final product treated according to plant procedure. The entire operation is dust free due to pneumatic transportation of the second milling stage product, and by aspiration of all other equipment.

68-1043

Szwarcztajn, E., K. Modrzejewski, and W. Olszewski. Investigations on obtaining NSSC pulps from the mixture of pine sawdust and birch wood chips by a continuous process (II). *Przegląd Papierniczy*, XXIV(1):1-5, Jan. 1968.

Investigations concerned with the determination of pulping conditions for mixtures of pine sawdust and birch wood chips in an experimental Pandia digester were carried out. The percentage of sawdust in a mixture of fibrous raw material amounted to 10 and 20 percent. The results were based on the properties of semi-chemical pulps, and on their yields. The investigations have confirmed the suitability of sawmill sawdust for the production of semi-chemical pulps from a mixture of pine sawdust and birch wood chips. It was found that a mixture consisting of birch wood chips, and 10 percent pine sawmill sawdust can be pulped under optimal conditions for chips from birch wood; however, when 20 percent pine sawdust is added, some changes in the pulping conditions are necessary. The economic effects, resulting from the use of sawdust as raw material for fibrous pulps production, were stressed. (Text in Polish)

68-1044

Tao, H. C. Taiwan's Changhwa bagasse board factory. *Sugar y Azucar*, 63(9):52-53, Sept. 1968.

The Taiwan bagasse board factory produces many kinds of bagasse board of a superior grade, including two-sided hardboard. The fibrous bagasse is passed through a series of

depithing machines which result in bagasse particles of about 4 mm in diameter and 25 to 30 mm in length which are then packed into bales of only 5 percent pith content. A cooking operation is used to soften the bagasse before refining. The quantity of water, temperature, and cooking duration have an influence on the quality. A sizing is added to the pulp (1 percent rosin and alum or ferrous sulphate). After passing through the forming machine, the boards are conducted through a wet roller press to reduce the moisture below 65 percent and to cut the boards in predetermined sizes. From there the boards pass to a dryer with automatically controlled temperature and humidity. An automatic unloader delivers the dried boards (moisture content 1-3%) to the cutters which accurately cut the finished board into predetermined sizes. To produce the hardboard, specially made soft boards are delivered to a multi-platen hardboard press. The pressing operation is conducted at high pressure (approximately 1,410 lb per sq in.) and high temperature (238 C). From here, the boards go to a stabilizing chamber which adds the required moisture for normal atmospheric conditions.

68-1045

Testin, R. E., and N. L. Drobny. Study of equipment that can be used in a reclamation system. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint H-7.)

A study conducted at Battelle Memorial Institute compiled a handbook of all available cost and performance characteristics of processes employed in solid waste recovery and utilization systems. Available cost and performance data was collected for 9 types of size reduction equipment: crushers, shredders, shears, hammermills, cage disintegrators, disc mills, drum-type pulverizers, rasps, and wet pulpers. Since the most widely employed means for separating solid waste is hand picking and sorting from conveyors, the entire field of industrial separation technology was surveyed in relation to magnetic separation, flotation, screening, vibrating tables, and optical sorting. Data was collected on four types of recovery processes: composting, waste heat recovery, chemical conversion, and pyrolysis.

68-1046

There's money in those fallen leaves. *Public Cleansing*, 58(9):458, Sept. 1968.

The Henry Doubleday Research Association's book 'Fertility Without Fertilisers' by Lawrence D. Hills, suggests that local authorities follow Toronto's lead in utilizing dead leaves from street trees. Suggested methods of making leaf mold are: collecting the leaves in pens for a year if space is available; and using a motor shredder to reduce leaves to a coarse powder. The material is low in nitrogen, and high in potash and phosphates. However, its greatest value is as humus.

68-1047

Three Taurus shredders from Fletcher and Stewart. *Materials Reclamation Weekly*, 113(4): 31-32, July 27, 1968.

The Taurus paper shredders are designed for the fast continuous reduction of bulky material to a predetermined

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size of approximately 6 in. in width. One field in which there is a great demand for the shredders is in the processing of waste paper, cardboard, box board, and fiberboard, where it is required to reduce bulky material to dimensions that will permit existing baling machines to work at maximum capacity, or allow manufacturers to install larger capacity baling machines. In automated systems, these shredders are essential to ensure that material with nearly constant density is delivered to baling machines.

68-1048

Tietz, I. Modern scrap utilization methods-steel scrap utilization. *Neue Huette*, 43(8):449-453, Aug. 1968.

Scrap, such as the bodies of discarded vehicles, causes problems in its reuse. Impurities such as rubber parts, paint, or lacquer stains, and non-ferrous metals are frequently found in this sort of scrap, which means that processing leaves a large amount of residue. A table shows the percentage of residues for various types of scrap. Moreover, the end product may be defective as is the case when steel has a copper content of more than 20 percent or a tin content of more than 0.025 percent. Difficulties are also posed by the constant increase of the chromium and nickel content in non-alloyed steel scrap. The influence of a high chromium content in scrap on steel is illustrated. All non-iron metals and all non-metallic impurities must be removed from the scrap, so that the melting process is not impaired. Some methods of preparing light scrap are discussed. How automobile wrecks are mechanically shredded, then thermally cleaned to remove all non-iron metals is described in detail. (Text in German)

68-1049

Ultrasonics free fibres from waste paper. *New Scientist*, 38(6):522, June 6, 1968.

Ultrasonic vibration is the basis of a highly effective way of recovering useful fibers from waste paper. The ultrasonic 'hydrofibrator' has been designed to remove printing ink, fillers, and other non-homogenous material such as plastics and lumps of metal from useful fibers without seriously degrading them. A thin aqueous suspension of waste paper, after a first rough screening to remove large pieces of metal, is expanded, through a nozzle, into a pipe with a vibrating plunger set axially in it. The bonds between the fibers are loosened, freeing minerals and filler from the floc and restoring the plasticity of the fibers.

68-1050

United Container Co. doubles capacity at new plant. *Paper Trade Journal*, 152(6):27, Feb. 5, 1968.

New equipment, efficient layout, and three computer programs have helped to double the company's production capacity of corrugated products per month in its new Philadelphia plant. In the old plant, five men were employed over three shifts to handle waste recovery; additional help was also employed simply to keep work areas clean and to push filled waste baskets to the baling room. Through its new system of semi-automatic and automatic pick-ups from 12 plant areas, the company hopes to reduce labor requirements substantially. The system separates and stores kraft, mixed,

and chip scrap from waste. Workers can activate the waste system at any one of the 12 area pick-up stations. Once a worker starts the system and selects the grade of scrap he wants to dispose of, an automatic lock-out prevents the other stations from being used. This prevents two different grades of scrap from being intermixed. It also prevents jam-ups from overloading. Trimmings from the corrugator and folder-gluer are picked up, and sheets too large to be fed to floor pick-ups are shredded and fed into the automatic baler. Five roof fans provide the suction for waste pickup. Four 25-ft-high cyclones for waste separation are also on the roof.

68-1051

US improved detinning process. *Materials Reclamation Weekly*, 112(14):18, Apr. 6, 1968.

A scrap tinplate shredding unit, linked to a magnetic handling and conveying system in a detinning operation, was developed. The tinplate on the steel is chemically removed and pumped to special settling tanks for recovery and further use. The shredded, detinned steel scrap is used by copper producers to recover copper via a chemical precipitation process.

68-1052

Used tires reused. *Science News*, 94(14):598, Dec. 1968.

The uses of discarded tires, which now number 100 million, are being studied at the Coal Research Center of the U.S. Bureau of Mines in Pittsburgh. Valuable chemicals can be distilled from tires, as can gas for heat and power. Shredded tires are fed into a reactor where they break down to produce large quantities of chemicals, oil liquids, gas, and tar. A series of tests at 500 C produced 140 gal. of liquid oils, and 1,500 cu ft of gas per ton of tires. The chemicals obtained from the tires are similar to those produced from coal carbonization.

68-1053

Utilization of red mud wastes for lightweight structural building products. Chicago, Illinois Institute of Technology Research Institute, Aug. 1968. 41 p.

A research program was conducted to demonstrate the feasibility of producing a lightweight building material suitable for both structural and insulating applications from red mud wastes. These wastes are residue materials resulting from the extraction of alumina from bauxite ores by the Bayer Process. The materials were studied in two forms, a slurry containing about 20 to 25 percent solids and a dry residue resulting from evaporation of the water. The research program was conducted in three parts: (a) studying the problem area by visits to alumina producing facilities; (b) characterizing a typical red mud by composition, particle size distribution, pyrometric cone equivalent, and specific gravity; and (c) investigating the feasibility of developing compositions and processes to form lightweight structural materials of controlled density. Foaming techniques employed to produce a series of material having densities ranging from 30 to 70 lb per cu ft with satisfactory strength were demonstrated. The program was performed for the U.S. Department of the Interior, Bureau of Mines, Solid Waste Research Program, Contract 14-09-0070-386.

68-1054

Experimental work. In Utilization of red mud wastes for lightweight structural building products. Chicago, Illinois Institute of Technology Research Institute. Aug. 1968. p.14-36.

The laboratory program was directed toward demonstrating the feasibility of developing a lightweight building product using the red mud. A flow diagram showing the phases of the program is furnished. Several methods of producing a solid foam were considered, the most economical and efficient process being mechanical foaming. In the formation of solid foams, the dispersion medium consists of the slurry, foaming agents, stabilizers, and binders. In producing foam structures by the mechanical whipping technique, a foaming agent is required which will produce sufficient uniform bubbles. The presence of cations in a highly alkaline solution is an environment in which foaming agents are susceptible to chemical attack, which is the situation in the red mud system. Once foamability of the red mud was established, a base composition was developed by the addition of a clay binder and a filler material (perlite). This composition contained 65 percent solids which consisted of 82 percent red mud, 15 percent ball clay, and 3 percent perlite. Two other additives investigated, which improved foam structures, were citric and oleic acids. The mixing, drying, and firing procedures are briefly discussed, as well as the development of lower density foams. Controlled shrinkage permitted production of structurally sound foams of controlled density with the highest strengths. The compositions that maintained integrity for densities from 70 lb per cu ft to 30 lb per cu ft are plotted.

68-1055

Vickery, J. R. The recovery and utilization of edible proteins from blood and trash fish. Food Technology in Australia, 20(7): 315, 317, 319, July 1968.

Fish flour or fish protein concentrate (FPC), a food additive for humans, is derived mainly from whole fish normally caught for the production of fish meal for animal feeding. Steps in the production of fish protein concentrate are described. Blood from meatworks is now processed into various animal feeds or fertilizers, but, since it contains high quality proteins, it is potentially a useful addition to the world's protein supplies. The solids content of blood is about 20 percent, comprising mainly proteins. Proposed methods for the preparation of edible blood powder are outlined.

68-1056

Wadie, K. A. O. Soil improvement practices in Ghana. Compost Science, 8(2):17, Autumn 1967-Winter 1968.

The several soil groups in Ghana covering the forest zone, coastal savanna zone, and interior savanna zone are briefly described. In the northern regions of Ghana, on the granitic soils, the farmers practice a settled system of farming in which the land around the compound is cropped continuously. The Extension Service of the Ministry of Agriculture has encouraged farmers to bed their cattle on straw and accumulate as much of the nutrients from the excreta as possible during the night. The compound land receives all the farm yard manure and household refuse. A mixture of grass bedding and animal droppings are

periodically applied to cereal crops grown around the compound.

68-1057

Waste paper use in Russia. Waste Trade Journal, 64(21):10, May 31, 1968.

The Soviet economy is suffering such a severe shortage of paper that the State Committee for Materials and Technical Supplies has announced plans to set up a waste paper collecting campaign. At present, about 18 percent of the paper usage is repulped. Most of the waste paper collected in Russia is put into the production of low grade packaging boards. Some organized efforts of schoolchildren who have been urged to make house collections of wastepaper are evident, but the most regular contributions are made by professional scavengers.

68-1058

Waste-profit, not loss. Textile Industries, 132(7):63-65, July 1968.

A system for handling reworkable waste in textile spinning plants consists of blowing the waste through a wool wheel fan, which mixes it while tearing up sliver and hard lap ends. All forms of reworkable waste are mixed in this manner and blown into a collector (an enlargement of the Lummus filter), where it forms a sandwich. The air is completely filtered and blown out into the room. This system, together with a tandem 38½-in. feeder, has resulted in a 10 to 15 percent reduction in spinning ends and better than 50 percent reduction in rejected laps. The equipment paid for itself within a year.

68-1059

Wastes converted to acids and vitamins. Chemistry in Canada, 20(12):11, Dec. 1968.

As part of a pollution control program to upgrade industrial wastes from chemical industries, K.L. Pinder and R. Branion, University of British Columbia, are investigating the biological upgrading of spent liquor from the calcium bisulphite pulping process. Using the bacteria *Propionibacterium freudenreichii*, the sugars in the waste liquor have been converted to propionic acid, acetic acid, and vitamin B sub 12. The vitamin B sub 12 is separated from the mixture by centrifugation, and propionic and acetic acids are then recovered by standard chemical engineering techniques.

68-1060

Weathersbee, C. Convert newsprint to steak. Science News, 94/31(9):218-219, Aug. 1968.

As an answer to the world's protein shortage, intensive cultivation of ruminants, (cattle, sheep, deer, giraffe, goats, antelopes, okapi, etc.) which can synthesize protein from the non-proteins in grass (primarily cellulose and water) is proposed. Due to the construction of their stomachs, ruminants could theoretically exist on pure cellulose, vitamins and minerals, and some source of nitrogen. If the processes of the animal digestion were more completely understood, it might be possible to raise large numbers of

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cattle and other ruminants on paper or wood cellulose, which is very abundant, and yet useless as food to man. Another proposal involves utilizing the already existing animals in an area, which live off the existing flora, and farming them to give the largest possible yield. The eland, which at 2,000 to 3,000 lb. is also a very efficient grazer, might be an important future source of protein.

68-1061

Why is Mercer-Stalco the talk of the alloy industry? *Waste Trade Journal*, 64(25): 6, June 29, 1968.

Recapturing value from scrap alloy steels is the basis for the rapid growth of Mercer Alloys Corporation, Greenville, Pennsylvania, a subsidiary of Whittaker Corporation. The company produces alloys for steel mills, foundries, investment castors, vacuum melters, specialty mills, and fabricators from either secondary or primary materials, using advanced metallurgical equipment and techniques. After sorting, scrap materials are prepared to mill specifications. Long rods are sheared, large castings burned down to size, and 'fluffy' materials are crushed and baled. The material is then assigned to a storage area, and made ready for shipment or consumption in the plant furnaces. Large lots of alloy turnings residues, and contaminated materials go through a different procedure. Pneumatic tubes convey samples and analysis results between laboratories and ships for constant quality control.

68-1062

Wide variations in secondary tin usage. *Materials Reclamation Weekly*, 113(8): 29, Aug. 24, 1968.

A recent statistical survey of secondary tin consumption in a number of countries indicates widely different levels and applications. In the United States, which is responsible for 3,380 long tons or nearly 40 percent of the world secondary tin metal consumption in 1967 of 8,800 long tons, bronze and brass accounts for about one-half of the total secondary tin usage and solder a further quarter. In West Germany and Japan, tinplate andterneplate were major end uses for secondary tin. Austria is the world's fourth largest secondary tin consumer, using each year roughly the same quantity of secondary metal as primary tin. Tinning, bronze, and brass were the two major end uses.

68-1063

Williams, L. R. Unique use of wastewater on leisure world golf course. *Western City*, 44 (2): 34, Feb. 1968.

A Laguna, California, golf course has been irrigated since its inception with renovated wastewater. Sludge, from drying beds of a water restoration plant nearby, has been used as a soil conditioner. The water is automatically applied to the golf course at the direction of a time clock. The plant is a 1.5 million gal per day activated sludge facility using the contact stabilization method. The effluent is pumped to a pond formed by an earthen dam, where it is held for later irrigation use. Irrigation water is drawn from the storage pond as needed, chlorinated for a minimum of 20 minutes, and then pumped into the irrigation system. Water sludge is concentrated in a 'picket fence' thickener, aerobically digested, and spread on drying beds. Sludge from the drying

beds is expected to be used as a soil conditioner on areas other than the golf course.

68-1064

Wood chips as basic material for bituminous pavings of sport fields. *Foerderung und Heben*, 18(5): 327, Apr. 1968.

A report on a doctoral thesis by Olli-Pekka Hartikainen, Helsinki, is given. In laboratory experiments, the suitability of some types of wood chips was tested. Chip size is of primary importance, and chip form is of secondary importance. The behavior of the wood chip-bituminous paving can be influenced by the type of bitumen selected and by additives such as rubber or cork. Ground bark from birch trees has all the advantages of wood chips, and, in addition, gives a high weather resistance to the paving. As a typical waste product which is presently used only as fuel, it is favorably priced. Certain difficulties and costs are involved in the conversion of bark into a suitable chip size. Although this poses no technical problem, it interrupts the normal production flow so that companies are not inclined to use the bark. Particularly for pavings applied in the cold state and in the open air, ground birch bark is an excellent material. The sports arena in Otaniemi (surface 3,096 sq m) was paved with a mass of wood chips and bitumen. It has now been in use for 3 years, and no problems or complaints have been reported. The same results were achieved with this wood chip paving in an open air installation which is also 3 years old. The paving is quite economical because it requires no maintenance. An illustration of the interior of the Otaniemi sports arena, which is the largest in Scandinavia Nordic countries, is given. (Text in German)

68-1065

Wood waste disposal provides heating. *Steam and Heating Engineer*, 38(444): 34, Nov. 1968.

At the Millwall, London, plywood box factory of Luralda Ltd., the monthly costs of waste disposal and central heating have been reduced respectively from £140 to £60 and from £200 to £70 through the installation of wood waste burning equipment from Stewart Automatic Boilers Ltd. Throughput of waste is approximately 5 to 6 tons per week, giving a gross calorific value of over 50,000,000 Btu. The waste is fed into a storage silo, where compacted materials are broken up, and then falls into a conveyor which stokes the fuel into the base of the furnace hearth. Complete combustion is achieved by means of dual air supply. Dust is subsequently removed by a soot and grit arrester before the exhaust gases are liberated.

68-1066

Wool waste economics in carding, rag-grinding and blending, etc. *Textile Manufacturer*, 94(1119): 107, Mar. 1968.

A new system of re-processing waste, which could save a medium sized woolcombing firm £ 10,000 per year, has been developed. During carding, approximately 1½ percent of the raw material is lost and is later sold as card waste. With the new system, the card waste is removed by suction through an overhead system and taken to a shaker which is used to clean and open the matted and solid fibers and extract impurities. The cleaned fibers are either fed back into the card through the hopper or fed directly into sacks.

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68-1067

Ash handling. Air Conditioning, Heating and Ventilating, 65(8):49-51, Aug. 1968.

Modern ash-handling equipment is required to effectively handle the 10 percent coal residue from industrial steam plants. Ash is usually removed from boiler ash pits and transferred to a storage bin every 8 hr. Discretion is necessary in sizing the ash-handling equipment to achieve lowest annual fixed charges and operating costs. The three types of ash handling systems are: pneumatic, hydraulic, and mechanical. The mechanical system consists mainly of portable devices, and it is used in plants producing less than 50,000 lb per hr. In pneumatic systems, an air stream produced by a mechanical steam or water exhauster transports ash from boiler ash hoppers and fly ash from dust collectors and traps to bins or silos. Used in small and large plants, these systems are low in initial cost and can move ash long distances. The components of the pneumatic ash-handling system are: fly ash intakes, which receive the ash from ash pits and hoppers; conveyor piping; an exhauster-cyclone separator, including primary and secondary cyclone separators; a steam exhauster unit and an air washer; a steam exhauster; a mechanical exhauster, to be used when high pressure steam is not available to power a steam exhauster; and ash storage silos and bunkers, the tile silo being recommended. The silo is the most expensive component. Ash is removed by gravity through segmental discharge gates and a chute to a truck below. Hydraulic ash-handling systems use water to transport ash to a dewatering or decantation bin that is periodically emptied. Fly ash must be conveyed separately by steam or mechanical exhauster to the silo. The system is much more expensive than the pneumatic type.

68-1068

Cannon, R. W. Proportioning fly ash concrete mixes for strength and economy. American Concrete Institute Journal, 65(11):969-979, Nov. 1968.

A method is presented for adding fly ash to cement to produce concrete of equal strength to concrete without fly ash. Effects of differing proportions of fly ash on water requirements, strength, and economy are given, along with a discussion of the effects of the fineness and carbon content of the fly ash and variations in strength of cements on cement requirements. A procedure is detailed for proportioning mixes, and sample problems are worked out. Comparisons are made between the cement requirements as determined by this method and cement which had actually been tested. The method was developed by the TVA, which has used fly ash in all classes of concrete for the past 12 years.

68-1069

Chopra, S. K., C. A. Taneja, and S. P. Tehri. Development of cellular concrete based on lime and fly ash. Research Industry, 13(4):189-191, Oct.-Dec. 1968.

Investigations on the development of lime fly ash based cellular concrete are presented. The cellular concrete blocks

prepared on both laboratory and commercial scales conform to the specifications laid down by the Indian Standards Institution for load-bearing and non-load-bearing lightweight concrete blocks with respect to properties such as dry density, compressive strength, modulus of rupture, drying shrinkage, and water adsorption capacity. The production cost for the blocks is considerably less than that for the conventional cement-based cellular concrete blocks. The material is ideally suited for the construction of prefabricated structures. It can also be used as a thermal insulation material in buildings, cold storages, etc. The use of this material leads to more buildings, reduction in transportation cost to the construction site, and reduction in foundation loads. Consequently, it is being used increasingly in the developing countries. Supporting data and a flow chart of the process are furnished.

68-1070

Coal fly ash to bricks. Congressional Record, 114(41):S2,749-S2,750, Mar. 13, 1968.

The article 'University Project Could Mean New Industry for Appalachia' from the Mar. 10, 1968, edition of the Beckley, West Virginia, Post Herald and Register stated that producing brick from fly ash can save industries money which would otherwise be used in hauling away the 20 million tons of ash residue which is produced each year. Production of bricks at the Morgantown Ordinance Works is in the experimental stage. The total cost of equipment, which includes a hydraulic press capable of turning out 3,000 bricks per hr, a mixer, and a kiln for firing bricks, is about \$180,000. Research is funded with a \$466,500 contract from the U.S. Office of Coal Research. The cost per ton of clay used for bricks varies, but fly ash has a relatively stable price. Fly ash brick is less dense, and its utilization requires fewer laborers. Fly ash can be produced in either metropolitan or rural areas.

68-1071

Coxon, P. Profit by sintering your flyash. Power Engineering, 72(4):52-54, Apr. 1968.

Sintered fly ash is used for structural concrete, building blocks, and floor screeds. Its properties also make it suitable for drainage and horticulture. The increased use of electricity has led to a large production of fly ash. Creation of a successful fly ash sintering plant has to take into account the handling of the dry fine fly ash and the variations in fineness and carbon content of the fly ash. Several plants are discussed, including one in Germany and several in Great Britain. The fly ash is mixed with water, then fired, with the carbon content being sufficient to sustain combustion. Fine coal is used to make up any carbon deficiency in the ash. Capital cost for a medium-size plant is about \$5.50 per cu yd per year, although the cost will depend on the variability of quality and quantity of fly ash, ground conditions, and demand for the finished aggregate.

68-1072

Fighting a mine fire with fly ash. Coal Age, 73(5):114-118, May 1968.

The injection of dry fly ash looks very encouraging as a method for controlling abandoned mine fires, stabilizing

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areas against subsidence, and remote sealing of passageways in active workings. The use of fly ash as a borehole sealer has been tried successfully at the Bruceton mine, and it is now being applied in fighting an abandoned mine fire in Lloydsville, near Latrobe, Pa. Boreholes of 6-in. diameter are drilled in single and double rows on 25-ft centers from the earth's surface into the mine's entries. These holes are then filled with dry fly ash, pneumatically injected from 20-ton-capacity trucks at 10 to 15 psi pressure and at a rate of 1 ton per minute. To date, over 40 boreholes have been flushed with a total of approximately 3,200 tons of dry fly ash which was furnished at no cost by the West Penn Power Company. When completed, the fly ash barrier in the mine will be 1,200 ft long from outcrop to outcrop and will be able to completely cut off the fire. For this application, fly ash proved superior to sand, crushed limestone, and granulated slag in that it showed better penetration into crevices and rubble, better water absorption properties, and better handling in cold weather. Since no water is required in the process, a major cost factor is also eliminated.

68-1073

Fly ash captures new market. *Power*, 112(9):78, Sept. 1968.

In the next 2 years, the New York Port Authority will utilize over a quarter of a million tons of fly ash, which will be obtained free of charge from nearby coal-fired plants, for various paving jobs at Newark and Kennedy airports. It was determined that variations in fly ash properties were of minor importance in the production of paving cement. The use of 12 to 14 percent fly ash in the LCF (lime, cement, fly ash) results in a product with a strength of from 800 to 1,400 psi. The fly ash is transported to the site by barges and trucks at a cost of \$2 to \$3 per ton.

68-1074

Fly ash problem solved on Carling brewery furnace. *Air Engineering*, 10(1):6-7, Jan. 1968.

A 27-year-old bituminous coal furnace was judged to be equipped with inadequate fly ash-collecting facilities and to be emitting quantities of fly ash particles larger than 5 mm. A separate ash-collecting unit for the furnace, due to installation problems, would have cost \$26,000. An alternative method was devised by routing the air to an ash collector on another furnace which could handle the ash output of both furnaces. The ducting and a barometric damper were installed by sheet metal workers at a cost of \$3,000.

68-1075

Faber, J. H. Fly ash utilization—problems and prospects. In *Proceedings, First Mineral Waste Utilization Symposium*, Chicago, Mar. 27-28, 1968. U.S. Bureau of Mines and Illinois Institute of Technology Research Institute. p.99-107.

The properties, qualities, and availability of fly ash are reviewed. At present, the major uses of fly ash in the United States are: mass concrete, ready-mix concrete, soil stabilizer, asphalt paving filler, lightweight aggregate, concrete blocks, pozzolan cement manufacture, portland cement raw mix, and oil well grouting. New or small-scale uses for fly ash which were tried and found successful include: additive for foundry

core sand and masonry mortar; blasting compound; soil amender; filler for several products such as roofing, fertilizer, soap, paper, rubber, asphalt, and tile; sanitary landfill cover; and mine fire control. A \$2-per-ton deficit for disposal of fly ash can be turned into a \$2-per-ton profit by proper utilization of this byproduct.

68-1076

Fly ash waste gains value from new process. *Water Pollution and Control*, 106(11):40, Nov. 1968.

Enceron Ltd. of Hamilton, Ontario, has developed a process to convert waste fly ash from coal-fired power-generating stations into valuable materials for the concrete industry. These materials include structural, lightweight aggregates to replace sand and stone and pozzolanic fly ash, used as an addition to portland cement. A prototype plant will have the capacity to process 200,000 tons per year of ash. The fly ash will be transported by pipeline from the silos of the generating plant to the process plant in a closed circuit operation to avoid air pollution.

68-1077

Faurie, J. C. The disposal of fly ash in coal mine workings (Part 1). *Coal and Base Minerals of Southern Africa*, 15(1):27-39, Jan. 1968.

Transvaal coal contains slightly over 25 percent ash, which remains as waste at power plants in the process of combustion. Since no suitable land was found near the Komati Power Plant for dumping, the Electricity Supply Commission (Escom) decided to put this waste back into the worked-out areas of the Koorfontein coal mine. Escom and the mine already have been transporting coal hydraulically through a pipeline over a distance of 1½ miles; consequently, it was only necessary to transport ash to the mine, and the return water could be usefully employed for the coal pumping. The success of the operation greatly depended upon the properties of the ash, which either was extracted from below the boiler in the form of clinker or came from the stack as a precipitate or deposit. After being transported, the ash settled at a relatively rapid rate, leaving clear water that could be decanted. Residual moisture was of the order of 7 percent, and it was a contributing factor to ash stabilization. After decantation, men could walk on the settled ash after a few hours. Aluminates and silicates present in the ash were responsible for the cementitious property and for the consolidation of the ash, which on drying became a hard, solid mass with a shear strength of 2,000 lb per sq ft.

68-1078

Fourie, J. C. The disposal of fly-ash in coal mine workings (Part 2). *Coal and Base Minerals of Southern Africa*, 15(12):27-31, Feb. 1968.

The rock mechanics aspect of ash disposal at the Koorfontein coal mine (Transvaal) and the success attained with ash filling at the mine are discussed. The daily output of the Komati Power Plant amounts to 2,000 tons of ash during a 6- to 8-hr flushing period. In order to convey this material with 2 million gal of water to the underground workings at Koorfontein, a 250-ft-deep, 10-in. hole was drilled, a size

suitable for taking a 9-in. casing pipe to the depth of the 20-ft soft measures. A similar casing is inserted from the bottom and firmly grouted in. Only one hole is required, since by suitable arrangement of valves, the return water can be pumped back during the off period. Ash filling in an upgrade and downgrade panel is discussed at length. Success of the operation is largely ascribed to the good roofing condition prevailing at the Koornfontein mine. Between 1 and 2 ft of coal were left on the roof. Since it was proven that ash filling adds to the strength of the pillars, consideration was given to a greater percentage of coal extraction. The use of ash as a floor for mining high-grade coal appears very promising. After consolidating the ash and using it as a floor for the next operation, a subsequent lift of the coal seam can be taken out. Using an existing pumping system, the cost of the borehole, pump, pipelines, and other preparatory work was kept to approximately R 7,000.

68-1079

Jarco, P., S. Majercak, V. Maly, and A. Majercakova. Pelletization of converter dust in the East Slovakian Iron and Steel Plant. *Hutnické Listy*, 23(10):679-684, Oct. 1968.

Converter dust amounting to 10 to 12 kg per ton is the waste of the oxygen converter steel shop in the VSZ plant. Methods for recovery such as returning dust into the converter in sacks or blowing into the melt through a special nozzle were not applied in practice. Other utilization techniques recommended involved the production of green pellets. Research on the material properties and pelletizing conditions indicated variable properties of the material (chemical and grain size composition) and also variable strength, which is sufficient, however, for the green pellets to be charged into the converter. (Text in Czechoslovakian)

68-1080

Lightweight aggregate—rosy but challenging future. *Rock Products*, 71(12):65-66, Dec. 1968.

Lightweight aggregates are being considered for skid-resistant surfaces for highways and airports, treatment of soils, and lightweight concrete blocks. Sintered fly ash plants are entering this field, and an association has been formed to promote and develop fly ash products. In 1967, the production of lightweight aggregate totaled 12,822,000 tons. The totals for the various products were: expanded clay and shale, 8,799,000 tons; expanded slag, 2,456,000 tons; pumice (natural), 833,000 tons; expanded slate, 649,000 tons; expanded perlite and exfoliated vermiculite, 105,000 tons.

68-1081

Lightweight aggregate development. *Materials Reclamation Weekly*, 112(25):16-17, June 22, 1968.

Aglite Engineering, Ltd., is manufacturing a lightweight aggregate for the building industry from waste materials. This has created great interest among foreign technical experts, and the plant was recently visited by 36 delegates from the U.S.S.R., Bulgaria, Japan, Germany, Poland, Spain, Venezuela, Italy, and Yugoslavia. The aggregate is manufactured from a mixture of coal waste and fly ash, but it can use other waste materials such as rice husks and desert quartz. Plans are being made to operate a plant in Kuwait.

68-1082

Murphy, E. M., M. O. Magnuson, P. Suder, Jr., and J. Nagy. Use of fly ash for remote filling of underground cavities and passageways. U.S. Bureau of Mines Report of Investigations No. 7214. [Washington], U.S. Department of the Interior, Dec. 1968. 27 p.

Experiments, detailed with drawings and data, show that dry materials which can be transported pneumatically will tightly fill underground passageways and cavities when injected remotely through a borehole. The parameters studied include: horizontal and inclined passageways, obstructions in the entry, water leakage into the borehole, dry material, and grout and slurry mixes. The materials studied were: fly ash, crushed and pulverized limestone, and sand. Fly ash, because of its low angle of repose and its good flow characteristics, produced tight, stable seals in inaccessible mine workings.

68-1083

Nishimura, H., and I. Osoegawa. Recent utilization of fly ash in Japan. *Journal of the Fuel Society of Japan*, 47(490):98-106, Feb. 1968.

The coal ash produced at power stations in Japan is generally divided into three categories based on the place of collection in the stations and is utilized in the following manner: fly ash, collected by electrical precipitators, is characterized by qualities that improve the strength, watertightness at a later age, and workability of concrete material and decrease its temperature rise when mixed in concrete. It is, therefore, mainly utilized in fly ash cement and pozzolanic materials. 'Green ash,' which is collected by the multi-cyclone and is a little coarser than fly ash, can be used as a special fertilizer for farms, because it contains more than ten nutrients necessary to the growth of plants and can improve the quality of soils. The crushed clinker, or 'coal sand,' collected at the bottom of boilers, economizers, and air heaters is often utilized as a road base stabilizer. Ashes could be used as base materials, provided that one layer is used directly and the others are well graded by other aggregates. All types of ash are good subbase materials. Vanadium, withdrawn from heavy oil ash produced by power stations, has been recovered to supply a part of the demand for fly ash in special steel making. (Text in Japanese)

68-1084

Noguchi, T. Utilization of coal ashes discharged from thermal power plant. *Energy and Pollution Control*, 20(7):5-12, July 1968.

Current principal applications and an outline of investigations for the development of new utilization of coal ash discharged from power stations are included. The ash is separated into three categories according to the positions of collection in power stations: (1) clinker ash collected at the bottom of a boiler with an estimated output of 700,000 tons per year; (2) clinker ash collected under an economizer, air heater, and cyclone, with an output of about 3 million tons per year; (3) fly ash from an electric precipitator which produced about 1.3 million tons per year. After referring to the properties of each ash, current utilizations are mentioned. Up to 650,000 tons of fly ash are utilized in concrete materials such as fly ash cement and pozzolanic material, grouting materials, raw

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materials for lightweight aggregates, admixture with clay for bricks and tiles, admixture with asphalt, and road base stabilizer. About 70,000 tons of cinder ash are used in fertilizers and soil conditioners due to the nutrients involved. Almost all cinder ash is wasted as landfill. Investigations on new uses of ash being carried out at the Technical Institute in Tokyo Electric Power are as follows: cinder and clinker ash as admixture for concrete block, low-strength concrete material, road base material, and lightweight air-entrained-ash concrete material; cinder ash as material for artificial lightweight aggregates, fine aggregates, and admixture with concrete; and clinker ash as road subgrade material and drain sand. (Text in Japanese)

68-1085

Peters, E. Non-clogging pump solves fly-ash removal problem. *American City*, 83(5):135-137, May 1968.

The original system for removing fly ash from the quenching water at the Skokie, Illinois, incinerator experienced considerable trouble due to the fly ash accumulation clogging the sump pumps. The solution was the purchase of a Mid-Whirl clogless pump and the erection of a steel tank with a capacity of 18 cu yd mounted 15 ft above ground. The pump, mounted directly over the quench-water tank, pumps the fly-ash-laden water into the overhead tank. The fly ash settles to the bottom, and the water flows over a vertical baffle at one end of the tank and returns to the quench water by gravity. When the overhead tank is full of sludge, one crewman backs the residue truck under the tank, shuts off the pump, and opens the hopper gates. The pump operates alternately on and off for 1 hr. It pumps 150 gal per minute against a suction head of 3 to 5 ft and a distance of 25 ft. The temperature of the quenching water averages about 160 F. Initial costs for the conversion versus costs of an alternate plan are discussed.

68-1086

Pilney, J. P., and E. E. Erickson. Removal of fly ash by fluidized bed techniques; final report. Minneapolis, North Star Research and Development Institute, Mar. 1968. 55 p.

A literature search confirmed the potential for use of fluidized beds for removal of particles; removal efficiencies as high as 99 percent by weight have been reported for 0.5-micron aerosols by a fluidized bed of negatively charged polystyrene beads. Little work has been directed toward deliberate use of a fluidized bed as a filter. The program has indicated that fly ash can be removed effectively by passing an ash-containing gas stream through a shallow bed of fluidized particles. Mass efficiencies, greater than 99 percent, have been obtained in a 4 in. diameter glass column with fly ash loadings as high as 10 grains per cu ft of entering air. If inertial impaction were the controlling removal mechanism, a 99 percent mass efficiency could correspond to a number efficiency of removal of about 40 percent of the particles. Other forces, such as electrostatic, appear to be important in the fluidized bed, and the difference in mass and number efficiencies may not be that great. Superficial gas velocities as high as 2 ft per second, and pressure drops as low as 0.5 in. of water gave good results. The ash used had a mass median diameter of 8 microns, and a number median diameter of 0.7 micron. All three mechanisms studied—self-agglomeration in humidified air, coating the surfaces of sticky particles, and

build up of fly ash on the surface of other particles—can be used to remove fly ash. The apparatus, procedures, materials, and bed media are described, the results are discussed, and a literature review is presented.

68-1087

Pilney, J. P., and E. E. Erickson. Results. In Removal of fly ash by fluidized bed techniques; final report. Minneapolis, North Star Research and Development Institute, Mar. 1968. p.22-44.

The results are discussed in terms of removal efficiency by weight. The removal efficiencies by weight, determined in this way, are always greater, and usually much greater, than the removal efficiencies by number. The results of the self-agglomeration studies are presented in a table. The relative humidity of the fluidizing air was greater than 90 percent. The superficial gas velocity in the bed was always 1.6 ft per second, and the static bed depth was normally 1.5 in. The pressure drop across the bed was usually 1.4 in. of water. The ash loading of air passed through the bed was between 0.5 to 1.0 grain per cu ft, except for one run. The removal efficiencies of the fluidized beds were between 82.5 to 88.9 percent for the loadings below one grain per cu ft, and 91.5 percent for the 4.03 grain per cu ft loading. Variation in the time of the run from 5 to 30 minutes did not cause the removal efficiency to vary greatly or to change according to any obvious pattern. At a superficial velocity of 1.6 ft per second, it is theoretically possible for 80 micron particles of density 2.5 per cu cm to be entrained in the fluidizing gas and carried out of the system. It appears from the data that self-agglomeration of fly ash in a fluidized bed does occur, and removal efficiency as high as 90 percent can be realized for the fine ash in a silica sand bed at a pressure drop through the bed of 1.4 to 2.0 in. of water and at a superficial velocity of 1.6 ft per second.

68-1088

Pilney, J. P., and E. E. Erickson. Literature review for fly ash removal study. In Removal of fly ash by fluidized bed techniques; final report. Minneapolis, North Star Research and Development Institute, Mar. 1968. p.45-51.

A literature review is presented on: the use of fluidized beds for gas filtration; the physical and chemical characteristics of fly ash; power plant data; methods for removing particulate matter from gas streams; and fluidization-state-of-the-art. The more pertinent papers found on gas filtration in fluidized beds are briefly discussed, and the others surveyed are annotated. The bed materials tested for sulfuric acid mist removal were: microspheres (aluminum silicate), silica gel, activated alumina, silica sand, and glass beads. Removal efficiency was found to be substantially constant during the life of the beds and independent of the entering concentrations that were studied. Nonporous bed materials, like silica and glass beads, showed a life too short to be practical, but porous materials like commercial microspheres, silica gel, and alumina picked up over 5 percent by weight of acid before sticking destroyed fluidization. Evidence presented indicates that fluidized beds may give higher removal efficiencies than fixed beds of the same material. In a self-agglomeration process, the freshly reduced metallic iron on the surface of the bed particles softens and becomes sticky above 1,400 F. Small particles of iron oxide in the

feed, stick to the bed particles, causing them to grow in size. In a reducing atmosphere, the captured oxide is reduced to metallic iron, creating a self-renewing sticky surface. An optimum size of the bed particles is required to prevent the bed from fusing together. A comprehensive background on fluidization is contained in three general papers. Other references contain useful information on pressure drop, bed expansion, and minimum fluidization velocity in fluidized beds.

68-1089

Refinery makes money from fluid coke fly ash. *Modern Power and Engineering*, 62(4):84, Apr. 1968.

Canadian Petrofina refinery is extracting valuable vanadium from the fly ash produced in the fluid coke boiler—at rates up to 25 ppm, and selling the vanadium at about \$1.25 per lb. The refinery processes Venezuelan crude oil which contains about 130 ppm of vanadium. The fly ash is recovered in an electrostatic precipitator and the vanadium is leached out with sulphuric acid in an agitated, fiberglass-reinforced, polyester tank, maintained at a minimum of 122 F by steam injection. The vanadium slurry is then put through a process that eventually produces 99 percent pure vanadium pentoxide in flake form, ready for shipment.

68-1090

Roman, G. H. You can save money with fly ash. *Coal Age*, 73(8):60-64, Aug. 1968.

Fly ash, a liability to most companies, can be turned into an asset in the form of high quality building products. Using fly ash in construction materials can also save money for utility companies to the amount of 1 to 2 cents per million Btu. This is because using pulverized fuel ash in cement produces a stronger, smoother, and more durable concrete which sells, usually, for about \$1 per cu yd less than regular concrete. Tests have been conducted which show that fly ash concrete, after 24 hr, has a higher compressive strength than regular portland concrete, and it continues to grow in strength over the years due to oxides of iron, aluminum, and silica in the ash which combine with the free lime, which is liberated as the concrete ages to give a stronger cement. Also, fly ash concrete blocks have only a portion of the air leakage of regular blocks (1/5), and the fly ash blocks are twice as strong. Under a pressure differential of 6 in w.g., the air leakage, through regular concrete blocks, is about 10 cu ft per min per sq ft of block surface whereas, with the addition of only 17 percent fly ash, the leakage is reduced to only 1.2 cu ft per minute. With a 30 percent mixture of fly ash, the leakage is nearly immeasurable. A structural fill made of fly ash and 25 to 30 percent water, produces a structurally sound base which actually improves with age. These uses provide an economical outlet for fly ash which turns a liability into an asset by producing a better, cheaper product.

68-1091

Romanek, W., M. R. Jackson, and A. Lieberman. Development of an automatic fly ash monitor; final report. Chicago, Illinois Institute of Technology Research Institute, Oct. 1968. [97 p.]

A prototype monitor for particulate emissions from municipal incinerators was designed, built, and field tested.

The instrument is installed on the stack some distance above the base, to ensure the monitor's presence in a region of laminar flow. The monitor samples a predetermined quantity of stack gas either isokinetically or at a known velocity, separates the particulate from the gas by means of a cyclone, and measures the amount of particulate collected using a beta gauge. For each sample, the time of sampling and beta attenuation is printed out on a paper tape at some ground level. This design concept is suitable for unattended monitoring operations, and automatic isokinetic sampling, while feasible, was not an essential requirement for adequately following stack loading. Results from the field test sites at Chicago, Milwaukee, and Brooklyn are given. Operational procedures are outlined, and the monitor design is illustrated. Recommendations are given and conclusions are drawn. Numerous appendices follow.

68-1092

Sherwood, P. W. Utilization of fly ash. *Gas und Wasserfach*, 109(7): 178, Feb. 1968.

At a recently held symposium, sponsored by USBM, the National Coal Association, and the Edison Electric Institute, it was agreed that fly ash is a waste material of considerable importance. While it is known that fly ash from coal has cement-forming abilities so that it can be sintered or collected and added to clay and portland cement products, there has been resistance to using it, because of its varying grain size, its irregular amount of unburnt carbon, and its changing structure. Considerable progress has been made in eliminating these. The University of West Virginia has reported promising developments in the use of fly ash as material for bricks. Lightweight products of sintered fly ash, manufactured by Consolidated Edison, could be used to take the place of the Portland cement used in the construction of dams. This will not only prevent frost damage, but it will also increase the strength of the concrete. (Text-German)

68-1093

Suzuki, T., N. Kawai, S. Ino, S. Toyama, K. Kodama, and T. Otake. Process development of artificial light weight aggregate from fly ash with pulp waste liquor. Reports of the Government Chemical Industrial Research Institute, Tokyo, 63(1):1-50, Jan. 1968.

In order to develop a light weight aggregate from the mixture of fly ash and pulp waste liquor, the properties of raw materials were measured and process engineering studies were carried out as follows: (1) Granulation: After confirming the possibility of application of a pan-type pelletizer for the granulation of these raw materials from the experiment on compression strength and wetability of powder, appropriate conditions for the granulation by this pelletizer were obtained, and the two stage granulation method and the usage of a three stepped pan were examined to make larger pellets. Further, the weakness found with the heating temperature range of 600 to 800 C was overcome by the addition of clay or water glass and quick firing. (2) Drying: Since it was found that the dried pellet is ten times stronger than the undried one, a band drier was installed between the pelletizer and the kiln. A drying test established the time and conditions for drying, as a design criteria for this process. (3) Firing test in the laboratory: All ashes tested here had

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bloating characteristics. The bloating temperature tended to rise with increasing basic components. Furthermore, higher concentrations of pulp waste liquor and larger size pellets increased the bloating characteristics. Also, it was verified that quick firing was preferred to slow firing. (4) Firing test by a small rotary kiln: To prevent pellets from melting in the kiln, a coating powder was adopted. For protection against abrasion of pellets in the kiln, the mixing of bentonite into flyash was effective. The method in which pellets were calcined before firing was not advantageous. Quick firing in the kiln produced moderately bloated pellets and reduced losses by abrasion. (Text-Japanese)

68-1094

Tenney, M. W., and T. G. Cole. The use of fly ash in conditioning biological sludges for vacuum filtration. *Journal of the Water Pollution Control Federation*, 40(8):R281-R302, Aug. 1968.

One method of sludge disposal is that of dewatering sludge by vacuum filtration, followed by incineration of the dewatered cake. The resultant ashes can be used as landfill or soil conditioners. The major restriction to this process is that biological sludge, because of its inherent compressibility, requires appreciable pre-conditioning by chemical additives to the sludge mass, a costly process. The use of fly ash as a sludge conditioner greatly enhances the dewatering of both activated and digested sludges. The ideal fly ash to accomplish this is one with a high carbon content and a particle size of from 10 to 30 microns. The use of fly ash has many advantages: low cost; elimination of the use of chemicals; adequate supply; ease with which sludge can be dewatered; contribution to the fuel value of the filter cake; use of a pollutant to remove a waste; and no liquid demand. The unique properties of fly ash suggest that further applications in the field of water and waste water treatment, or in the area of reuse of wastewater should be investigated. Tables, charts, and a list of references are included.

68-1095

Using fuel ash as a soil improver. *New Scientist*, 38(593):130, Apr. 18, 1968.

Agricultural research is finding further uses for the pulverized fuel ash piling up outside coal-fired power stations. These include using it as a means to improve the water-holding capacity of coarse sandy loam. The largest dose of ash, equivalent to 200 tons per acre in the top 12-in. of soil, significantly increased the soil's available water capacity. The results of tests suggest that one important advantage is improved crop establishment. If problems of toxicity, arising from the boron content of some types of pulverized fuel ash, can be overcome, then the ash may find an important use as a soil improver.

68-1096

Vivier, M. Utilization of fly-ash for road work in France. *Mitteilungen der Vereinigung der Grosskessel-Besitzer*, 48(3):219-224, June 1968.

The use of fly ash as filler in road construction is a novelty, and is still in the experimental stage. Promising results have so far been achieved by experiments in laboratories and by

road construction projects in northern France. The first section of road constructed with fly ash showed a water accumulation of 45 percent in the layer below the fly ash, and water drainage pipes had to be installed. Moreover a layer of slag now separates the fly ash from a layer of slate. Sand is used on the road banks. Since the drainage pipes are rather expensive, extensive measurements are now being taken at a road section constructed in the above manner but without pipes. Four cu m of fly ash, which had not been compacted very well, settled less than 10 cm per year, and that no settling occurred after that period of time. Not much is known yet about the properties of fly ash to resist frost. By experience, we know that the upper crust of several cm freezes and defrosts without creating any bumps in the road. Laboratory experiments with four different types of ash from four different power plants confirmed this. Ash mixed with construction material, which is difficult to use with cement, changes the grain size distribution of that material. It also saves cement due to the pozzolanic properties of ash. An example for this would be fine, sludgy sand which cannot be compacted in this state, but by mixing with ash and cement, it can be used. By adding granulated blast furnace slag to the ash its strength can be increased since it can be better compacted. At first equal parts of slag and ash were used. Later, mainly for economic reasons, a mixture of 50 to 70 percent ash, 20 to 40 percent slag, and 6 percent cement was used. This mixture could be well compacted (to 95 percent of the maximum density). At present, experiments with mixtures where lime is substituted for cement are being conducted. One million tons of fly ash have been used so far in France for road construction, and valuable information has been gathered but much more research is necessary. (Text-German)

SANITARY LANDFILL

68-1097

An abandoned strip mine is to fill. *Environmental Science & Technology*, 2(6):402-405, June 1968.

With the help of a \$126,000 Public Health Service grant, the Maryland Health Department is now operating a model landfill in an abandoned mine near Frostburg, Allegany County. After winning public acceptance and securing matching funds from municipal and county authorities, a 21-acre site was selected and leased. Work in the strip mine, which is 1,900 ft long, 50 ft wide at the bottom and 110 at the top, and 35 to 50 ft deep, was started in spring 1967 with the construction of a system of ditches to drain the mine and divert run-off from surrounding areas. The landfill is presently receiving about 250 tons per week of refuse from 16,000 to 18,000 inhabitants of Frostburg and Allegany County, and is estimated to last 10 to 15 years. Junk cars are not accepted, for lack of compacting equipment. Fly ash is accepted only in winter, when it is used as cover instead of the frozen overburden. Trash is covered usually within 1½ hr and always at the end of the day. The mine overburden provides ample cover material, which is now used excessively in relation to the amount of solid waste, i.e. 9.3 acre ft per year per 10,000 persons served, as against the 6 acre ft amount deemed sufficient. Costs come to about \$1.40 per person per year, and could be reduced to \$1.00 if the landfill served more people. Collected data on dump vehicle type and

number, type and area of refuse, and weather conditions will aid in establishing a comprehensive State plan.

68-1098

Boyle, E. Role of sanitary landfill in waste disposal. *Air Engineering*, 10(10):23, 34, Oct. 1968.

A sanitary landfill is a construction project for reclaiming land as well as a refuse disposal operation. It does not give rise to air pollution or to pollution of the ground and surface waters in a properly engineered landfill. The variables to be considered in estimating the cost of a sanitary landfill operation are the distance the refuse must be transported, the type of soil, the equipment required, the availability of soil for cover material, the location and depth of ground water, and the quantity of refuse received. A sanitary landfill is often used in conjunction with an incinerator for disposal of bulky items which the incinerator cannot handle. Hi-density compaction is being used to reduce the volume of the refuse handled at a sanitary landfill, and to reduce transportation costs. Composting has not proved to be practical in the United States, either because of unfavorable economics, or due to nuisance conditions which arise from the operation.

68-1099

Buell, D. Haverhill sanitary landfill clean-solid waste disposal-III. *Congressional Record*, 114(42):S2844-S2845, Mar. 14, 1968.

While 200 lb of solid waste fill a cubic yard in a conventional dump, 700 lb per cu yd can be compacted by a bulldozer in a landfill. The Japanese are experimenting with an even greater compaction of 1,800 to 2,000 lb per cu yd. At Haverhill, Massachusetts, some garbage is still sent to piggeries, but the rest goes to the sanitary landfill, which contains 16 ft of rubbish, accumulated over 2 years of continuous dumping, compacting, and daily covering with fill in two 8-ft layers. Since the operation lies 200 ft from the Merrimack River, pollution is avoided. A 16-ft-deep hole has been dug in one corner to receive rubbish during winter as a precaution against fierce winds. A local rat exterminator visits monthly, although no rats have been found to date. Only one bulldozer, one man running it, and one supervisor are required. When the landfill is completed and covered with 2 ft of fill, it can be used as a marina, recreation area, or factory site.

68-1100

Coppa, R. B. How to start a sanitary landfill. *American City*, 83(3):85, 87, Mar. 1968.

Armed with a list of provisions set up by the town administrators and the State Health Department, including the requirement of buffer zones, shrub planting for screening, maintaining a 150-ft distance from a stream and a 4-ft barrier of earth between refuse and ground water, fencing, no burning, no scavenging, and the appointment of a 'watch dog' committee, the Town of Glastonbury, Connecticut, opened a new landfill site. It consisted of a total of 55 acres, of which 25 are to be used for the sanitary landfill. The town, with a population of 19,500, contributes 40 to 50 tons of refuse daily to the fill area. The operators use one Caterpillar crawler tractor to compact and cover the refuse. A chipper

operates in the brush and demolition area and will accept logs up to 6 in. in diameter. Chips from the machine are used in conjunction with sand and gravel to provide cover material. Heavy metals and appliances are loaded onto an open trailer which is hauled to a city scrap dealer weekly. Tires are removed periodically by a private contractor. A letter commending the Town of Glastonbury for its landfill operation was received from Archie B. Freeman, regional program chief, Solid Wastes Program, Public Health Service, in which he said that, 'This solid waste disposal facility is a model operation and is one of the best maintained and operated sanitary landfills in the North, if not in the United States.' A breakdown of cost expenditures is also given.

68-1101

County of Los Angeles, Department of County Engineers, and Engineering-Science, Inc. Development of construction and use criteria for sanitary landfills: an interim report. Cincinnati, U.S. Department of Health, Education, and Welfare, 1969. [267 p.]

The County of Los Angeles, California, is conducting a 3-year program of research and investigation for the development of construction and use criteria for sanitary landfills. The program was developed in cooperation with the U.S. Public Health Service through a grant. Objectives of the first year program include: (1) a study of the existing state-of-the-art in construction and operation; (2) an evaluation of gas movement in certain existing sites; (3) review of literature regarding possible effects of sanitary landfills and ground water quality; (4) laboratory experiments for testing flow rate of gas through various soils; (5) development of solutions for controlling gas generated in sanitary landfills; (6) field operations of gas sampling and analysis and settlement surveying. The first annual report covers 10 chapters in addition to a list of tables, appendices, and figures. The chapters covered include: introduction; sanitary landfill practice; selection of landfill sites and scope and results of studies; gas movement through porous media; design and implementation of field gas barriers and control devices; the effect of sanitary landfills on ground water quality; completed sanitary landfill land uses; code considerations for construction and use of sanitary landfills; and summary, conclusions, and recommendations.

68-1102

Cummins, R. L. Effects of land disposal of solid wastes on water quality. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 29 p.

Water pollution caused by improper solid waste disposal is a serious problem. The possibility of pollution will exist as long as solid waste is disposed of in or on the land. Every attempt should be made to minimize the possibility of contamination. Each site should be selected and considered individually. The purpose of the report is to provide information relative to water pollution that may be caused by solid waste disposal. Definitions, site descriptions, water quality criteria, potential hazards, case histories, recommendations, and tentative guides are included. The information is designed to give some insight into the problems that may occur and the methods for solving them. Infiltration and percolation of rainfall runoff can produce leachates that may cause ground water contamination. Three conditions must exist in order to have

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contamination by the process of leaching and groundwater travel. The site must be over, adjacent to, or in an aquifer; there must be saturation within the fill; leached fluids must be produced, and the leachate must be capable of entering an aquifer. When leaching does occur, the groundwater in the immediate vicinity of the fill, approximately 1,000 ft downstream, can become polluted and unfit for human and animal consumption, or for industrial and irrigation uses. Evidence that physical characteristics, biological quality, and chemical composition of surrounding water are affected by quality and quantity of solid wastes conditions is well known. Bacteria normally do not persist in underground water in the direction of flow for more than 50 yd, and seemingly important bacteria are seldom found below 4 ft, and never below 7 ft. Various case studies, some conclusions, and a bibliography are included.

68-1103

Davis, K. Planned landfills cut costs and complaints. *American City*, 83(12):102-104, Dec. 1968.

As a result of an overhaul of the entire refuse disposal system in Fort Worth, Texas, there were significant changes throughout the system. Fly ash and soot no longer blanket the houses near the two incinerators; incinerators were shut down, the open dumps and landfills were converted to sanitary landfills; and less money is spent for refuse disposal (only 51 cents a ton) than before. The previous projected cost of waste disposal by sanitary landfill was \$1.13 per ton, as opposed to an incineration cost of \$5.25 per ton. Land reclamation could also bring big dividends to the city. Due to the efficient usage of machinery and equipment and an automated records system to keep tabs on tonnages, landfill availability, and machinery costs, the actual cost of landfill is much below that of the previous estimates. As the population expands, the 14-year plan calls for the regular addition of new landfill machines and new landfill areas. Selection of the sites will depend upon: costs; proximity to refuse sources; topographic, soil and water table conditions; convenient access to major thoroughfare-freeway systems, and land reclamation effects.

68-1104

Solid waste disposal report for counties of Manatee and Sarasota, Florida. Philadelphia, Day and Zimmerman, Inc. 1968. 73 p.

Only one of the current landfill operations in both counties can be classified as a sanitary landfill based on public health standards. This is the North Sarasota County landfill located southeast of the City of Sarasota, Florida. The South Sarasota County landfill located east of Venice should be improved to meet the specifications of a good sanitary landfill. Enough sanitary landfill space appears to be available in Manatee and Sarasota Counties, within relatively economical travel distance for packer trucks, to accommodate all of the two counties' refuse through 1980. It is recommended that each county establish a department responsible for all solid waste disposal, and that all burning practices at landfills be discontinued. Each county should also contract with private dealers to haul abandoned automobile bodies and large home appliances to the Tampa shredding plant for disposal. If Manatee County purchases the entire 320-acre Lena Road site for sanitary landfill of

solid waste and obtains an option on an additional 275 acre site, and if Sarasota County purchases an available 400-acre site, these, with the existing landfills, would provide the counties with sufficient landfill space through 1980.

68-1105

Historical background. In Solid waste disposal report for counties of Manatee and Sarasota, Florida. Philadelphia, Day and Zimmermann, Inc., 1968. p.4-6.

Virtually only one method of solid waste disposal is practiced in both counties, and that is classified as landfilling. The landfill operations now in existence range in character from open dumps with uncontrolled burning to sanitary landfilling. Currently in Manatee County, backyard burning of household refuse is permitted on a regulated basis. In Sarasota County, no backyard burning of household refuse is permitted. On-site open burning of demolition, construction, and land clearing debris is permitted on a regulated basis throughout the county, including the City of Sarasota. The Cities of Bradenton and Palmetto in Manatee County have a combined garbage and rubbish collection service twice a week. In Sarasota County and the City of Sarasota, garbage and rubbish are segregated and collected separately twice a week. Although a small amount of solid refuse, such as demolition and land-clearing debris, is disposed of by on-site burning in each county, the bulk of all solid refuse generated in each county is disposed of in landfills. This includes garbage, rubbish, and bulky items such as large appliances, which are collected and delivered to the site by a municipally owned collection service or a franchised collection service.

68-1106

Current disposal methods. In Solid waste disposal report for counties of Manatee and Sarasota, Florida. Philadelphia, Day and Zimmerman, Inc., 1968. p.7-18.

Currently, two methods of sanitary landfilling are being used in each county: the daily cut and fill method, and the trench fill method. The cut and fill method is the daily excavation of small areas, or cells, and the dumping and compacting of refuse in these cells. The trench fill method involves the excavation of a large trench, or cell, that will have the capacity of several days, weeks, or months for solid waste disposal. A combined total of seven landfill sites are located in Manatee and Sarasota Counties. Each landfill was evaluated in accordance with the recommendations of the U.S. Department of Health for sites located in residential areas. Oneco landfill, Palmetto landfill, City of Bradenton landfill, North Sarasota County landfill, South Sarasota County landfill, Town of North Port Charlotte landfill, and City of Sarasota landfill were evaluated. The primary reasons for classifying the landfills as poor are their small size, inadequate supervision, and the lack of sufficient cover material and proper equipment.

68-1107

Potential landfills. In Solid waste disposal report for counties of Manatee and Sarasota, Florida. Philadelphia, Day and Zimmerman, Inc., 1968. p.21-22.

Lena Road Site (Site 1) was approved by the County Commissioners and the State Board of Health in November

1967. However, delays in the purchase of this site have been encountered by the county. The tract has a total area of 320 acres, of which the county has been interested in purchasing 80 acres for a county landfill operation. Hauling distance to this landfill from this population center of the county is approximately 8 miles. The 80-acre tract of land will have 388,000 cu yd of space available for landfilling. Two potential sanitary landfill sites were visited in Sarasota County. Each site is approximately 400 acres in size, and both are located in thinly populated, relatively level, underdeveloped agricultural areas. Each will have 1,940,000 cu yd of space available for landfilling, if the entire 400-acre tract is used.

68-1108

The deposition of non-putrescible industrial wastes near Bonfol. *Schweizerische Bauzeitung*, 86(27):480-481, July 1968.

Amidst the woods of a mountain range which forms the watershed between the North Sea and the Mediterranean is a large waste disposal site. Here nonputrescible residues from the chemical industry located in the area of Basel, Switzerland, are dumped. Trailer trucks transport daily about 30 tons of solid wastes, as well as sludges and filter cakes from 16 chemical plants (about 10,000 tons per year) to this dumping site. A layer of clay 5 m in thickness protects the groundwater. The imperviousness of the clay layer is checked regularly. The dumping site is well drained. The water running off from the dump site is collected and transported to Basel. The dumped wastes thus remain dry. When the dump site is filled to capacity, it is covered with a clay layer of 2 m thickness. On top of that half a meter of humus is heaped and trees are planted. In the last 6 years, 50,000 tons of chemical wastes were disposed of this way. The dump site is a source of considerable income for the municipality of Bonfol. Some regulations were worked out between the participating industries and the municipal government. (Text in German)

68-1109

District of Columbia dump will no longer pollute. *Clean Air News*, 1(1):13-15, Jan. 24, 1968.

The fires of Kenilworth Dump, which have been polluting the air of Washington, D.C. for 25 years, will be extinguished and the 125-acre dump will become a park. The project is partly financed by the Solid Wastes Program of the Public Health Service's National Center for Urban and Industrial Health. A \$1,100,000 sanitary landfill demonstration project will replace the dump. Under sanitary landfill procedures, each day's trash will be crushed and buried beneath layers of clean earth to contain odors, keep out rats and other vermin, and prevent combustion. When the terrain is suitably graded for recreational purposes, the completed landfill will be covered with 3 ft of earth, including a layer of topsoil, and then it will be seeded to establish turf.

68-1110

Dunn, W. L. Refuse filling of a swamp in a fresh water lake. *Civil Engineering*, 38(1):60-62, Jan. 1968.

At a site near the University of Washington campus, 166 acres of swampland were converted to usable acreage. When

the work of recovery began in 1933, the swamp, much of it over 60 ft deep, generally had the consistency of thick sludge. The original fill included household waste, rubbish, ashes, stumps, lumber, and rubble. During the years of filling there were two separate disposal operations: (1) domestic garbage or household waste was collected and placed; (2) earth cover was temporarily dumped on top of the cell placed the previous day, and then pushed over the top face of the new cell at the end of the day. Settlement of peat, drainage and burning of waste gas, and the effect of fill on water quality are considered. Swampland that has been reclaimed by filling with refuse placed over peat will never become entirely stable. However, it is quite suitable for automobile parking, open storage, athletic fields, open playing fields, and certain kinds of structures.

68-1111

Elevating scraper speeds work on landfill. *Public Works*, 99(6):152, June 1968.

A self-supporting sanitary landfill in Lucas County, Ohio, serves four communities and part of Toledo. About 2,000 cu yd of refuse are handled each day with residents paying from \$0.50 per cu yd for refuse and \$0.50 for an auto truckload to \$1.00 for a pickup truckload. An elevating scraper excavates a trench 70 to 80 ft wide, 120 ft long, and about 8 ft deep, moving about 300 cu yd per day of earth. Refuse is compacted with a tractor equipped with a special U-shaped bulldozer blade. Next, each layer is covered with a 6-in. compacted layer of clean earth, and when the trench is filled, a 2 ft cover is placed and compacted. The scraper is able to spread cover material evenly and is effective in adding to the compaction. The landfill is a three-man operation.

68-1112

Experts to set guidelines on landfill operations. *Public Health News*, 49(1-2):23, Jan.-Feb. 1968.

Eleven experts have been called together by the National Center for Urban and Industrial Health to develop standards for the planning, design, and operation of sanitary landfills. A landfill is a process of burying solid waste, a technique gaining increased acceptance in the United States. 'Solid waste' is the 800 million lb of waste that is thrown away every day, ranging from junked cars to garbage. Publication of the guidelines will aid public officials, consultants, and private operators to develop and improve the operation of sanitary landfills. The guidelines will not be regulations, standards, or criteria, but rather factors and elements, the application of which will improve the operation of landfills and minimize potentially adverse effects on the environment.

68-1113

Friedman, W. M. Demonstration of solid waste disposal machine in consolidation of several separate disposal operations into one county operated project. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint B-2.)

The Niagara County Solid Waste Agency, which was established in 1966, investigated the feasibility of a sanitary landfill operation in the county. It was concluded that a

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small eastern site would be operated as a conventional sanitary landfill operation, and a large western county site would utilize a D & J Refuse Machine designed to economically dispose of solid waste by controlled burial. Under a health department ruling that all subdivision plans would be reviewed for solid waste disposal facilities, a suitable vacant, industrial-zoned property was located for the western site. The advantages of operating the refuse machine are estimated to be lower operating costs per ton of waste and lower land requirements per ton of waste.

68-1114

From landfill to heliport. *American City*, 83(10):42, Oct. 1968.

The new downtown heliport in Richmond Virginia grew out of a deep gully. The first step consisted of a sanitary landfill to raise the level nearly to grade. A bulldozer and a rubber-tired loader compacted and covered the refuse. Then followed a cap of 4 ft of compacted earth fill, excavated from the site of the city hall under construction nearby. As well as elevating this site to the proper grade, the final fill also accelerated the rate of compression of the refuse underneath and strengthened it enough to accommodate the helicopters. The \$31,000 heliport on the landfill may be only the first of several located throughout the city. It is noted that the only other community to create a helicopter landing area by building a sanitary fill is Winnetka, Illinois.

68-1115

Fungaroli, A. A., R. L. Steiner, G. H. Emrich, and I. Remson. Design of a sanitary landfill field experiment installation. Ser. 1, No. 10. Philadelphia, Drexel Institute of Technology, Nov. 1968. 32 p.

The field facility which has been developed as part of a comprehensive study of the hydrologic functioning of a sanitary landfill is described. This field facility is a companion to the laboratory lysimeter described in another report. The test area is a portion of the Southeastern Chester County Sanitary Landfill located in Kennett Township, Chester County, Pennsylvania. The following topics are discussed: climatic conditions, geology, site plan, instrumentation, instrumentation schedule, sample analysis, and refuse placement. The detailed design, installation, and activation of the field test site being used to study the behavior of sanitary landfills located over metamorphic bedrock and in the soils derived from it are discussed. Charts, tables, and illustrations are furnished.

68-1116

Gerhart, J. O. City gives 5-year franchises to contractors in new areas. *Solid Wastes Management/Refuse Removal Journal*, 11(3):11, 28, Mar. 1968.

Longview, Washington, a city with a population of 28,000 in 1968, was founded in 1922 by a private businessman, and is one of the few cities in the state to be thoroughly planned before being built. The city has continued on the same basis, and as part of its planning it provides 5-year franchises on any new annexed areas to private wastes hauling contractors, who operate outside the city limits. The city's Sanitation

Department has employees who direct sanitary landfill operations and proper deposition of refuse hauled to the landfill by the general public, and perform other related duties. A sanitary landfill, which can be used by the general public, is located about 2 miles from the city limits near the Cowlitz River, which provides cover material for the landfill. The city owns two contraction units, along with 15 1-yd containers and a hoist. Sidewalk litter containers are being placed in the streets. Proper sanitation and wastes disposal methods are brought to public attention through advertisements. Offenders against regulations are warned, and help is given to citizens in meeting regulations.

68-1117

Gershowitz, H. Model landfill contract recommends very stringent performance bond. *Solid Wastes Management/Refuse Removal Journal*, 11(7):16-18, 20, 24, July 1968.

The model sanitary landfill contract and model instructions to bidders, which was prepared by the National Solid Wastes Management Association for discussion by the industry, by cities, and by the Solid Wastes Program, is presented. The model contract recommends a stringent and uniform performance bond provision which states that the contractor shall furnish such a bond, executed by a responsible surety company. In the case of failure of the contractor to perform, a penal sum equal to one-half of the estimated annual price payable to the contractor, based on the preceding year's payments (current year, during the first year of the contract) up to a maximum of \$100,000 per year, is payable to the city. Penalties are also provided in case of failure on the part of the contractor to satisfactorily dispose of putrescible wastes. Compensation is to be given to the contractor for such changes in landfill operations, transfers, or additions, as give rise to increased costs; and an adjustment to the face value of the contract based on changes in the U.S. Department of Labor consumer price index is suggested as part of the contract.

68-1118

Gillham, R. W., and L. R. Webber. Groundwater contamination. *Water and Pollution Control*, 106(3):54-57, May 1968.

A network of piezometers was used to characterize quantitatively and qualitatively a zone of contaminated water beneath a barnyard. The piezometers provided access tubes to obtain hydraulic potential measurements, hydraulic conductivity values, and water samples for chemical analysis. These data were used to construct quantitative flow nets. Analysis of water samples indicated that the concentration of nitrogen in the groundwater increased significantly as the water passed beneath the barnyard. The quantitative contribution of nitrogen made to the groundwater by the barnyard was calculated to be 1.89 times 10 to the minus three lb per hr under the conditions of July 5, 1967. The reliability of this would depend primarily upon the confidence in the measurements of hydraulic conductivity and the distribution of the hydraulic potential. It was concluded that the barnyard contributed to the nutrient enrichment of the groundwater.

63-1119

Hudson River park will be built on disposal ground. Solid Wastes Management/Refuse Removal Journal, 11(10):72, Oct. 1968.

A riverfront park on a 1/2-mile long, 7 1/2-acre site along the banks of the Hudson River will be constructed on a former landfill for incinerator residue which was operated by the City of Yonkers. The project is expected to cost more than \$1.5 million. Half the funds will be involved in converting the landfill, and the other half, in park improvement.

68-1120

Johnson, D. E. Road commission operates county refuse disposal sites. Public Works, 99(6):126-127, June 1968.

The St. Clair, Michigan County Road Commission selected a sanitary landfill site, half of which consisted of an open pit mine approximately 30 ft deep from which clay had been removed. About 12 miles west of the populated Port Huron, the site is centrally located and on a good highway. An International TD15 tractor with a refuse handling blade was purchased to move and compact the refuse and spread the cover material which was obtained from the bottom of the excavation for the first lift. Some industrial wastes are accepted, such as rubber by-products, papermaking wastes, and a limited amount of sludge from municipal waste treatment plants. Written contracts with all cities wishing to use the main sanitary landfill and satellite areas are required. The consideration is 20 cents per \$1,000 of State equalized value of the jurisdiction. A transfer station is being considered to serve the southern part of the county.

68-1121

Kansas site handles 1,000 tons weekly. Solid Wastes Management/Refuse Removal Journal, 11(5):46, 89, May 1968.

In January 1965, a private company was awarded a 5-year contract by Kansas City, Kansas, for the collection of both residential and commercial wastes. This company operates with refuse-collection and landfill vehicles that are leased from local dealers, thus avoiding the necessity of operating a vehicle-maintenance shop. A 42-acre site near the Kaw River serves as the operations base for a sanitary landfill. Trash and organic waste are collected on separate routes. All loads entering the premises, including those brought by the public, must be covered by the winds. Fees are charged by the load, from \$.50 for a private automobile to \$4.00 for a packer load. Composition of solid wastes is similar to that handled elsewhere. Material is deposited in an assigned area for spreading evenly by on-site tractors. Clean earth fill, stored during the day in a spoil area adjacent to the dumping point, is used for cover material. The site is open 6 days a week, 8 hr per day. Communications with the working crews, which are scattered through a 56-sq mile area in and about Kansas City, is maintained by means of a two-way radio.

68-1122

Klein, S. New building constructed on sanitary landfill. Public Works, 99(10):125-126, Oct. 1968.

The most suitable site for the location of the public works building of the City of Wenatchee, Washington, was a low

lying site which was subjected to flooding each year. Sanitary landfill was used to raise the height of the area approximately 25 ft. The landfill had been placed only 2 years previously, and it varied in depth from 20 to 30 ft. Construction of a reinforced concrete beam on piles was chosen. Holes were dug by a well driller, sinking a pipe to underlying gravel strata. Reinforcing was placed in the casing, and the casing was filled with concrete. A total of 17 piles were constructed by this method at a cost of \$350 for drilling only. A steel building, measuring 60 by 120 ft, was placed on the piles. The building will allow storage for 20 vehicles. Ventilation was accomplished by installation of four 10 ft ridge ventilators with 12-in. throat and damper, and the floor will be finished with asphalt hotmix. Future plans include construction of a similar building to house the Street, Water, and Sewer Departments.

68-1123

Landfill replaces controversial town dump. Public Works, 99(10):112-113, Oct. 1968.

An injunction from the Massachusetts State Attorney General ordered the controversial town dump of Clinton closed. Without preparing specifications, the town engaged a local contractor unfamiliar with landfill methods, who merely buried the collected refuse under loads of sandy gravel. The responsibility for the landfill was then turned over to the Department of Public Works which decided on a modified progressive trench method. Cover material is spread on the compacted refuse during the day as the fill progresses down the trench. As the fill advances, refuse is covered with a 6 in. layer of burned-out material from the face of the old dump. Since much of the industrial and commercial waste is plastic, which is highly flammable and burns with great amounts of smoke and heat, this material is buried quickly. The cost of this operation is \$.85 per ton including machine rental, maintenance, and operator's wages.

68-1124

Lobb, E. Changing a city dump into a sanitary landfill. League of North Dakota Municipalities, July 1968. 6 p.

A sanitary landfill costs more than a dump in direct operating costs, but is less expensive when side benefits and intangibles are considered. Land value is usually improved, and rats, flies, and smoke are eliminated. Prior to converting a dump to a landfill, the city should eliminate burning of refuse, paper, and tires within its limits. Tractor operators can flatten car bodies easily. A trench was made in a lagoon outside Esmond, North Dakota, for burial of 200 abandoned cars which were flattened by a dozer and then covered. Refuse disposed in a sanitary landfill should be compacted to conserve space and provide a firm fill. A layer of dirt should cover each day's deposit to seal it. The area should also be fenced.

68-1125

Lucker, B. Communities jointly solve refuse problem. Public Works, 99(10):156, Oct. 1968.

Benton and St. Joseph, along with three smaller municipalities in Michigan, formed the Northwest Berrien

Sanitary Landfill

Sanitary Authority. A \$392,000 bond issue was passed to purchase land for a sanitary landfill and equipment to handle the 700 cu yd per day of refuse. A steel wheel compactor compresses the waste as soon as it arrives, which means that the trench excavation will hold the maximum amount of refuse. A scraper cuts, hauls, and spreads 100 yd per day of cover dirt over the compacted refuse.

68-1126

Merz, R. C., and R. Stone. Special studies of a sanitary landfill: final summary report January 1, 1964 to December 31, 1968 and third progress report January 1, 1964 to December 31, 1968. Los Angeles, Department of Civil Engineering, University of Southern California, Dec. 1968. [214 p.]

The special three-part study, covering the years from Jan. 1964 to Dec. 1968, describes the construction of model landfills and their treatment under selected environmental conditions. The purposes of the investigation were: to study the percolation through the landfill as a result of application of sufficient water to maintain a golf course type turf; study the percolation through the landfill as a result of application of sufficient water to simulate the rainfall pattern of a temperate climate (Seattle); study the effects of aerating a landfill; measure settlement of both aerobic and anaerobic landfills; study the quality of gas produced in the landfills receiving the various treatments; and determine the volume of gas produced by a known quantity of refuse decomposing under anaerobic conditions. Progress reports, plus a final summary report covering the entire period are presented. Extensive data, tables, illustrations, and conclusions are included. This investigation was supported in whole by Public Health Service research grants with the construction of test cells by the County Sanitation Districts of Los Angeles County.

68-1127

Murdoch, R. F. Selection and placement of soil cover material in a sanitary landfill. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint B-3.)

A research project was initiated to define those soil properties which are significant in the determination of the applicability of a cover material in sanitary landfill operations. Both laboratory and field studies are being employed to characterize soils from existing and proposed landfill sites, and from numerous areas in the United States. The determinations being performed include natural water content, specific gravity, combined mechanical analyses, Atterberg limits, and standard and kneading compaction tests. As soon as laboratory test results become available, a general evaluation of cover material placement procedures will be undertaken.

68-1128

Muzzi, A., A. Borgioli, and N. Vescia. Pollution of a water table by the dumping of urban solid wastes. *Nuovi Annali d'Igiene Microbiologia*, 19(6):451-467, Nov.-Dec. 1968.

Beginning in April 1967, about 10,000 cu m of solid waste from Rome, Italy, were dumped for about 2 months on land

otherwise not used for this purpose. Pollution of well water now exists in this area, about 20 m below the ground. A systematic study was made from May 1967 to August 1968 to determine possible alterations of the physical, chemical, and biological characteristics of the water table caused by the dumping of refuse. Samples were taken from six farmhouse wells, 15 to 20 m in depth, and at distances varying from 2 to 180 m. Between the surface and the water table, there were 1 m of humus, 5 to 6 m of medium-coarse gravel mixed with yellow sand, and about 15 m of almost pure gravel. Water samples were tested for temperature, pH, electrical conductivity, ammonia, nitrites, nitrates, organic substances, chlorides, free carbon dioxide, total alkalinity, hardness, solid residue, iron, manganese, phosphates, anionic detergents, total microbe agar culture count at 37 C, and coli count. Well number 6, due to its location, could be used as a control for the other five. The effects of pollution were first noted 5 months after the dumping of the refuse, and took place most rapidly during the month of November, which corresponds to the rainy season in that area. Test results indicated that this water table was poorly protected. Little value could thus be given to much of the chemical and bacteriological data obtained, with the exception of the mineralization factors: alkalinity, hardness, solid residue, anions, and cations. (Text in Italian)

68-1129

Noring, F., G. Farkasdi, A. Golwer, K.-H. Knoll, G. Matthes, and W. Schneider. Decomposition of impurities in groundwater penetrating from dumping sites. *Gas und Wasserfach, Wasser, Abwasser*, 109(6):137-142, Feb. 9, 1968.

Two dumping sites were selected which are in an area where groundwater seeps through porous soil. Site A has been used for dumping industrial and domestic wastes since 1945. Site B is located in an abandoned gravel pit. The wastes dumped here contain oily and sulfurous material, and they are extremely rich in organic substances. This dumping site is below the groundwater level, so that leaching of the waste material is constant. Thus, the decomposition process in groundwater can be particularly well observed. The geology of the areas around the two dumping sites is illustrated. Test results of site B are given. The residues remaining after evaporation of groundwater samples increased from 327 to 675 mg per liter before the groundwater flow reached dump site B, and changed to 949 to 4,538 mg per liter after it passed it. A conception of the amount of organic substances dissolved in the groundwater can be obtained by observing potassium permanganate consumption, which decreases with increasing distance from the source of pollution. An oxidation reaction first consumes the oxygen dissolved in the groundwater, and then reduces the nitrates and partially the sulfates. Thus a so-called 'reduction zone' is formed directly underneath the dumping site. This zone is characterized by the absence of dissolved oxygen, sometimes by a complete lack of nitrate and a reduction of the sulfate, by the formation of ammonium and iron (II), and by an increased groundwater temperature. A transitional zone follows where oxygen is found again, which leads to the precipitation of Fe (II) ions in form of Fe (III) hydroxide. The groundwater at site A shows little change in its chemical composition. The residues remaining after evaporation of groundwater samples increased from 601 mg per liter, before the disposal site, to 1070 mg per liter immediately after the disposal site. No 'reduction zone' was found here. (Text in German)

68-1130

North Eastern Centre discussion on controlled tipping. Public Cleansing, 58(3):139-145, Mar. 1968.

The disposal of refuse by controlled tipping was discussed at a joint meeting of Corporate Members of the North Eastern Centres of both the Institute and the Association of Public Health Inspectors in Kingston upon Hull, November 1968. The reasons for the depreciation of controlled tipping methods were given as follows: the changing character of refuse which does not lend itself to consolidation; mechanical methods used at tips which do not appeal to consolidate tips as well as manual workers; lack of adequate sealing materials to prevent flies from emerging from the tips; and lack of adequate screening to prevent windblown refuse from littering the countryside. It was suggested that pulverization begin in the refuse vehicle. Other problems discussed included birds attracted to tips, bulky wastes, tip fires, and dangerous industrial wastes.

68-1131

Ohio county landfill project provides site for a ball park and picnic area. Solid Wastes Management/Refuse Removal Journal, 11(6):22, June 1968.

A 27-acre site, formerly part of a burning dump which served as the main refuse disposal area for 150,000 persons in Sylvania and neighboring communities, has been redeveloped by a private company. This firm covered the burning dump, landscaped the site, built roads, and returned the land to the county for recreation. The remainder of the area is now a sanitary landfill facility covering 104 acres of land that had been classified as non-productive. The landfill operation is unusual in that it employs an elevating scraper to dig trenches for refuse, and to provide clean earth cover for the compacted waste. The trenches are filled with refuse, the material is spread and compacted by a crawler tractor, covered with a 6-in. cover from another trench section, and eventually sealed with a 2-ft thick layer of clean earth. The speed of the scraper, which is said to excavate 300 cu yd per day, allows the company to keep the open dumping face to a minimum. Approximately 2,000 cu yd of residential, commercial, and industrial waste are delivered daily to the site, and are handled by a crew of three men.

68-1132

Pennsylvania studying landfills. Clean Air News, 2(9):1-2, Mar. 19, 1968.

Work at Pennsylvania's Drexel Institute of Technology on sanitary landfills includes construction of a lysimeter in which the dissolution or decomposition of wastes can be observed under controlled conditions. The lysimeter is a specially-built vessel consisting of a double walled steel tank, with fiber glass insulation between the walls. It is 14 ft high, 6 ft wide, and 6 ft deep. It is loaded with typical solid waste from Southeastern Pennsylvania, including garbage, metals and plastics. Instruments, including thermometers, are imbedded at various levels. It has been found that the refuse in the test heated up to 150 F in 10 days and that a leachate, a liquid decomposition product, began to appear in less than a week's time. Determinations of how quickly refuse decomposes, the type and amount of leachate which exudes from the buried refuse, and how much gas is produced are planned.

68-1133

Phelps envisions Everglades for future landfill site. Solid Wastes Management/Refuse Removal Journal, 11(10):24, 38, 46, Oct. 1968.

In an interview, J. Grady Phelps, vice chairman of the Florida chapter of the South Florida branch of APWA, stated that in the long run, the Everglades would be an ideal landfill site, but would be expensive, because railroads would have to lay many miles of track; however, the network would enable the southeastern and southwestern parts of Florida to haul to the Everglades. He also notes that pulverization is a useful adjunct to an incinerator operation. Composting is unworkable at present, largely on economic grounds. Disposal of abandoned automobiles has become possible through use of hammermills. Also, junked cars have been successfully hauled into Biscayne Bay to make a reef. Eventually, all cities will have to use incineration, and while landfill cannot be completely dispensed with, the need for it can be greatly reduced through high-temperature incinerators, which will operate at as much as 3,000 F.

68-1134

Portable wind fence controls litter at landfills. Public Works, 99(1):108, Nov. 1968.

Two wind fences have been designed by National Disposal Contractors, Barrington, Illinois for the effective control of blowing paper at sanitary landfills. One fence is made of five sections, each 9 ft 9 in. high, 10 ft wide, and 20 ft long. These are joined by four 5 ft sections of wire which holds all sections together and produces a fence with an overall length of 120 ft. It is designed to stand up under a 25 mph wind with the face of the fence covered with paper. Each section of the fence is mounted on a skid and is pulled as a train to the desired location. Another fence, also all metal, is made of three sections, each 21 ft long and 14 ft high with a top overhang. Metal skids permit easy placement when refuse is being deposited.

68-1135

Ralph Stone and Company, Inc. The sanitary landfill site. In Land reclamation by accelerated stabilization; first annual progress report. Los Angeles, Aug. 1968. p.3-5.

A demonstration project is underway at Santa Clara's 73.2 acre sanitary landfill. It is centrally located, and is accessible by paved roads. The soil is easily excavated, and a public water supply and electrical power are provided. Fencing allows adequate protection from public intrusion, even though the site is in an isolated area with limited residential habitation. The geology of the land indicates that it was once an arm of the San Francisco Bay, and the soil consists of fine to medium grain permeable soils. Land subsidence is occurring and is expected to continue to occur while over pumping of the ground water continues. The groundwater at the site is of minimal quality. The climate is mild and temperate and the average annual rainfall is 20 in. The requirements of the California State Water Quality Control Board for landfill sites is given in an appendix.

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68-1136

Ralph Stone and Company, Inc. Refuse and soil. In Land reclamation by accelerated stabilization; first annual progress report. Los Angeles, Aug. 1968. p.6.

Refuse used to fill the cells originates in the residential areas of the City of Santa Clara and other materials are excluded from the test site. Refuse characteristics are being obtained as the cells are filled, and general records of the seasonal variation in refuse composition, moisture content, volatile matter, and other pertinent characteristics are being developed. On a dry weight basis, about 35 percent of the refuse is garden trimmings, 55 percent paper, 3 percent plastics, and 7 percent metals, glass, ceramics, and other inerts. Moisture varies seasonally from 71 percent in the spring to 15 percent in the fall. Volatile content averages 84 percent on a dry weight basis. The soil is fine sandy clay overlaying a clay silt subsoil. The latter is being used as cover material, and, as available, asbestos cement and certain other inert industrial waste and demolition products are used to supplement this to provide a surface for winter access and to exclude surface drainage.

68-1137

Ralph Stone and Company, Inc. Cell construction. In Land reclamation by accelerated stabilization; first annual progress report. Los Angeles, Aug. 1968. p.7-12.

An existing anaerobic cell was excavated and then recomacted into a new cell; a result, a 25 percent expansion in volume was experienced. A preload test cell was constructed to determine the foundation and settlement characteristics of a normal anaerobic landfill when supporting one kip per sq ft load. Aerobic test cells were divided into two areas: the aeration cell area which distributes air into the refuse, and the residue cell area which is used to dispose of the oxidized residue. The excavation plan and the aeration system, which consists of two underdrain systems, a blower, valving, and appurtenances are described. Preparations were made so that the internal composition of the cell remains unchanged during the sampling procedure. The refuse used to fill the cells is weighed, and the cells are surveyed periodically to determine volume. Definitive compaction densities will be calculated, settlement plates and benchmarks will be installed, and subsequent volume reduction and settlement will be recorded. Access holes will be bored and test equipment will be installed to measure internal and external temperatures, humidity, moisture, differential and total cell settlement. Climatological data is compiled to relate internal cell activity to external climatic conditions.

68-1138

Ralph Stone and Company, Inc. Supplemental studies. In Land reclamation by accelerated stabilization; first annual progress report. Los Angeles, Aug. 1968. p.24-25.

A study of pertinent literature was carried out; a bibliography of the more important writings on the subject of sanitary landfills and their operation is included. Operating landfills in San Joaquin, San Mateo, and Alameda Counties, and various County and City of Los Angeles sites were visited. A record is maintained of the characteristics of each load carried to the demonstration site to provide a tabulation of the computed truck density. Time and motion studies will

be carried out to determine how long it takes to weigh and unload various stake trucks and compactor vehicles. A master plan for utilization of the landfill site has been proposed utilizing clean fill for areas designated for building sites, but this has not been approved by the City Council.

68-1139

Reinhardt, J. J., and G. Rohlich. Solid waste reduction/salvage plant; an interim report; City of Madison pilot plant demonstration project, June 14 to December 31, 1967. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 25 p.

U.S. Public Health Service Demonstration Grant No. DO1-UI-00004 is designed to analyze the economic feasibility of milling solid wastes and landfilling the product. The project includes analyses of settling, gas and temperature production, and leachate within the fill. The initial 6 months' experiences encountered in milling rubbish, combined refuse, and garbage with a Gondard mill are described. Handling and disposal methods are included. The extensive conveyor system for charging and product transportation resulted in several problems that were partially alleviated by modifications. Both automatic and manually controlled feed techniques were employed; however, optimum production was obtained by the latter method. Production rates were lower than predicted, but all three grate sizes tested were satisfactory. No optimum size grate has been determined. Combined domestic refuse, domestic garbage only, and rubbish were the three types of milled material tested. Only milled garbage cells appeared unacceptable for landfilling without cover, as compared to control sanitary landfill cells of unmilled solid wastes. Initial conclusions include greater fill densities for landfill space conservation without odor or vector problems. No suitable market was available for rejected metal and salvaged paper. Special collection and handling procedures were instigated for coordination with the milling operation. Accounting figures and mill diagrams are included.

68-1140

Remson, I., A. A. Fungaroli, and A. W. Lawrence. Water movement in an unsaturated sanitary landfill. Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, 94(SA2):307-317, Apr. 1968.

Knowledge of the occurrence and movement of moisture in sanitary landfill is basic to a knowledge of the generation and movement of water-borne contaminants. Moisture routing methods based upon the equation of continuity are extended to provide an approximate method for predicting vertical moisture movement through and out of a sanitary landfill. Using the routing method, predictions were made of the effect of emplacement season and initial conditions on the moisture regimen of a hypothetical sanitary landfill in Chester County, Pennsylvania. Results show that the time that elapses before the appearance of the first leachate depends upon the season of emplacement and the initial moisture content. The infiltration capacity and permeability of the soil cover can be adjusted by the choice of cover soil or the use of artificial impermeable materials. The storage capacity of the soil and fill might be adjusted by the design of thickness, choice of materials, use of additives, and treatment.

68-1141

Sanitary landfill for the entire region of the Ruhr Valley. Gas und Wasserfach, 109(20):555-556, May 1968.

The most important single project of the Siedlungsverband Ruhrkohlenbezirk (SVR = Housing Community of the Ruhr Coal Area), the erection and operation of a central waste disposal site, is now being realized. The association bought a 257-hectare plot for 18.7 million DM. The larger part of this plot will eventually become a recreation area, but in its present state, it is swampy and barren. The most economical way to turn this area into a recreation site is to use it as sanitary landfill for a period. This would give the region a badly needed dumping place and, at the same time, would fill in the swamp. The location of the site is very favorable. It can be expanded, is easily accessible but quite remote from housing, and is large enough to provide a dumping site for 25 to 30 years. There is no danger of polluting the ground water because of the closeness of the Emscher River. The entire plot will not be turned into an extensive sanitary landfill. Only a small section at a time will be designated as a dumping area. The deposited waste will be immediately covered with earth and other noncombustible material and then compacted. Once a section is filled in, it will be sown with grass, and a new section will be designated for dumping waste. It is assumed that the residues from the waste and sludge incineration plant in Karnap will go to this sanitary landfill along with noncombustible wastes from Essen, Gladbeck, and Gelsenkirchen, as well as the domestic waste of the City of Recklinghausen. An estimated 550,000 tons per year will be dumped at this new site. In a few years the smaller cities in the region will also need to use the disposal site. (Text in German)

68-1142

Sites scarce as California area triples population in 20 years. Solid Wastes Management/Refuse Removal Journal, 11(2):46, Feb. 1968.

Santa Clara County population tripled between 1950 and 1966, rising from 291,000 to 920,000 in these years. The massive increase in the number of residents required sweeping changes in numerous areas of governmental activity, particularly in public health practices. Disposal of refuse in open dumps was stopped in 1965. The transition was made relatively smooth through a highly cooperative program in which the Health Department, the County Counsels' Office, and the contractors joined forces to develop a practical refuse disposal ordinance, with provisions for fly and rodent control. New equipment proposed for collection and transportation of refuse is studied by the Health Department before being put into service. Liaison between the public and the refuse collection industry is maintained through the Santa Clara County Refuse Disposal Agency. In 1964, the county Health Department, with grants provided by the Federal government, studied residential area fly problems. Currently it is also conducting a similarly funded study aimed at refining the results obtained from the first one.

68-1143

Smith, C. D. A sanitary fill inside the city. American City, 83(4):90-92, Apr. 1968.

A landfill in Cedar Rapids, Iowa, is operated by using two units—a bulldozer equipped with U-shaped blade, and a

self-loading scraper. As the refuse trucks dump in an assigned spot, the bulldozer spreads the refuse evenly. While this is being done, the John Deere scraper is picking up clean earthfill in an adjacent spoil area. The scraper brings approximately 8 yd of fill and spreads a 6-in. layer over the compacted refuse. When an area is completed, a 2-ft cap of fill material is spread by the scraper. In this quarry landfill, the fill stockpile is the old berm from the overburden taken from the quarry. Nearly 100 ft of overburden were originally removed from this quarry. As the fill operation continues, the permeable quarry walls are lined with a layer of approximately 3 ft of clay. This prevents liquids and gases from the waste fill from contaminating surrounding ground water. A sump area is always left somewhere in the pit. The sump collects the rain runoff and seepage. This keeps the rest of the fill area completely dry. The sump, when filled, can be pumped into the nearby river. It is almost impossible to eliminate voids created by material that cannot be completely collapsed during initial compaction. Pulverized fill material could provide a finished site that could be used almost immediately for new construction.

68-1144

Solid Wastes Technical Advisory Committee. Solid wastes: a regional approach. Denver Regional Council of Governments, [1968]. [12 p.]

In the five-county Denver metropolitan area, 90 percent of the landfills are substandard. Of the 31 sites studied, only 45 percent had a rodent control program, and only 13 percent covered their refuse daily. A cooperative, regional approach to solid waste management is the most effective solution. Solid waste pollution, like air and water pollution, is no longer a respecter of political boundaries. There are also economies of scale in using the regional approach; larger and fewer disposal facilities improve control of pollution and health hazards. From the planning standpoint, regional administration has the advantage of overview. Disposal sites can be engineered and spaced to match the population distribution within the area. Small communities and agencies would receive the benefit of professionally educated and knowledgeable administrators, something they cannot now afford. Three things need to be done before establishing a regional program. Enabling legislation is required to authorize establishment of such a regional body. An authorization is required to proceed with a study to examine and evaluate the details of such a system, and a comprehensive public information program informing citizens of the problem and solutions must be initiated.

68-1145

Sorg, T. J., and H. L. Hickman. Sanitary landfill facts. Public Health Service Publication No. 1792. Cincinnati, U.S. Department of Health, Education, and Welfare, 1968. 26 p.

An efficient method of solid waste disposal is the sanitary landfill. Preliminary planning for a sanitary landfill involves the application of sound engineering principles in site selection, design, and operation. Advanced planning should include the selection of a competent designer and/or consultants. An active public information program is vital in order to acquaint citizens with the working and benefits of a landfill. The crucial task of selecting a site requires an estimate of volume or land area needed. Other considerations

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to review are zoning restrictions, accessibility, hauling distance to the site, and availability of cover material. Geological and climate conditions, as well as fire control facilities, should also influence site evaluation. Essentially, design plans and specifications determine how effectively the landfill will be operated. After a custom plan is developed, economic and sanitary operation depends on competent administration. Problems from rain and winter weather are handled individually. High public health standards and careful nuisance control are factors which distinguish an exemplary sanitary landfill. Air and water pollution control requires close attention. Limiting nuisances such as odor and wildlife make the site much more acceptable and adaptable for reclamation purposes. Equipment and on-site facilities are dependent on site size, as are initial investment and operating costs. Other advantages and disadvantages of sanitary landfills are explored.

68-1146

Sowers, G. F. Foundation problems in sanitary landfills. *Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers*, 94(SA 1):103-116, Feb. 1968.

The growing scarcity of building sites close to cities, combined with the increasing volume of wastes, will make it imperative to use sanitary landfills for future building sites. The sanitary landfill, however, is a poor supporting medium because it is weak, settles substantially, produces hazardous or obnoxious gases, and is extremely difficult to work in. These difficulties can be minimized or eliminated by utilizing present engineering techniques for construction and foundations. Sanitary landfills can be improved and future development made possible at minimum costs by the segregation of materials such as cars, debris, stumps, and tires. Compacting the fill materials can minimize future settlement. Wet and dry materials can be mixed, and heavier, more effective compaction equipment can be used. The structures to be built must be designed to absorb settlement and to resist the corrosion and gases inherent in the fills.

68-1147

Steiner, R. L., and A. A. Fungaroli, eds. Analytical procedures for chemical pollutants. Research project on pollution of subsurface water by sanitary landfill. Ser. 1. No. 8. Philadelphia, Drexel Institute of Technology, June 1968. 26 p.

A research project on pollution of subsurface water by sanitary landfill and analytical procedures for chemical pollutants are compiled and presented. The procedures described apply to both the laboratory lysimeter and field installation samples taken from the Chester County landfill site described in another report. Liquid samples, gas samples, solid samples, and a list of appendices are presented.

68-1148

Steiner, R. L., and R. Kantz. Sanitary landfill, a bibliography. Public Health Service Publication No. 1819. Washington, U.S. Government Printing Office, 1968. 37 p.

A comprehensive bibliography of articles related to sanitary landfills was selected from a wide variety of American and British periodicals. Entries are arranged chronologically, ranging from 1925 through 1968. The search to obtain this information was supported by a Public Health Service

research grant from the Solid Wastes Program to the Drexel Institute of Technology. The publication represents a revised edition of a 1967 bibliography published by Drexel Institute (Series 1, Number 2). An extensive list of references used in the search is also included. Articles reflect a wide range of topics related to sanitary landfills: numerous city or State landfill reports; economic feasibility studies; disease and pollution aspects; manpower and equipment factors; and potential and restrictions for the sanitary landfill.

68-1149

Stephenson, M. E. Thermophilic metabolism in solid substrates; progress report no. 1. East Lansing, Michigan State University Division of Engineering Research, Sept. 1969. 21 p.

The principal variables affecting the decomposition of biodegradable solid wastes by thermophilic, aerobic microorganisms are under study. Specific analytical methods and laboratory procedures are being developed which will culminate in a valid experimental model of the sanitary landfill system. The equipment consists basically of a replicate series of 14 liter fermentation cells with provisions for internal mixing to insure uniform aerobic conditions and recirculation of liquid through the test sample. The temperature and pH of the contents are measured on a semicontinuous basis. Studies of assay of mixed solid refuse samples obtained from the Meridian Township sanitary landfill indicated that a measure of total organic carbon provided a satisfactory estimate of reactive carbon. The adopted method is presented in the appendix. Data show that carbon which is lost from the solid phase appears quantitatively in the gas phase as carbon dioxide, and that nitrogen generally remains fixed as organic nitrogen, with only a fractional loss appearing as ammonia or nitrate in solution. The carbon to nitrogen ratio decreased from 27 to approximately 15. A respiratory quotient of approximately 1.0 has, in general, been observed continuously during the entire decomposition process, indicating the existence of only aerobic oxidation processes.

68-1150

Stone, R., E. T. Conrad, and C. Melville. Land conservation by aerobic landfill stabilization. *Public Works*, 99(12):95-97, 138, 140, Dec. 1968.

An attempt was made to accelerate landfill stabilization by aerobically decomposing compacted refuse before its final disposal. Aerobic decomposition generally results in a reaction in which water is formed instead of methane. The refuse was compacted into a cell which had been underlain with a series of gravel-covered perforated pipes through which air may be forced. After aeration, the residue was transferred to a final residue cell where it was recompacted and received a soil cover. It was expected to thus reduce the settlement and methane production typical of an anaerobic landfill and permit earlier use of the land. The test cell measured 50 ft wide, 200 ft long, and 17 ft deep, and was underlain with a gridwork of gravel and enclosed perforated clay pipes which were connected to a large blower. The blower could deliver 1,200 cu ft per minute under a total pressure of 10 in. of water. The cell contained a total of 2,940 tons of refuse with an overall density of 1,253 lb per cu yd by wet weight. Temperatures rose rapidly to 190 F and remained at or near this level until aeration was terminated.

As much as a 40-percent reduction of the refuse was realized using these processes. Costs were estimated on a weight basis and were calculated (preliminary) at about \$50 to \$95 per ton delivered.

68-1151

Stone, R., and M. Israel. Determining effects of recompaction on a landfill. *Public Works*, 99(1):72-73, Jan. 1968.

Recompaction of a landfill, a project sponsored by the Public Health Service in conjunction with the City of Santa Clara, was conducted to demonstrate the possibilities of land reclamation through accelerated stabilization. Approximately one-half of the solid waste disposed of at the landfill is demolition debris and other trash delivered by individuals and private haulers, and the rest is city-collected rubbish excluding garbage. Seasonal variation in waste composition, moisture content, and volatile matter was determined. Sandy clay was used to provide 24 in. of final cover. A 1-year-old anaerobic cell was excavated, and the excavated solid waste was recompacted into a new cell. Settlement markers have been placed on a recompacted cell and other cells to determine relative settling rates.

68-1152

Stundl, K. Decomposition processes in the ground and their influence on the quality of the groundwater. *Gas-Wasser-Wärme*, 22(7):142-147, July 1968.

The decomposition processes in various layers of soil above a groundwater current are reviewed. The humus layer holds the largest amount of microorganisms and is thus responsible for an intensive biochemical decomposition. However, plant growth and especially the fertilizer used have an important influence on the decomposition process. Experiments were conducted to observe the decomposition process of water penetrating into the soil through a layer of manure on the surface. The results show that a thick humus layer and a subsequent layer of fine sand and gravel purify the water so that no negative influences on the groundwater are to be feared. Any destruction of the humus layer has unfavorable effects on the groundwater, so that it is especially dangerous to use abandoned gravel pits as waste disposal sites. Unfortunately, this is done frequently because many municipalities in Austria lack composting or incineration plants. Very often ash from power or remote heating plants is dumped at such sites. No agreement has yet been worked out on the necessary precautionary measures. One possible way to protect the groundwater would be the sealing of gravel pits with clay. Another suggestion is the use of fiber material remaining from paper and cellulose production. The British method of the sanitary landfill should be made known and adopted. (Text in German)

68-1153

Two Tennessee cities, one town, operate disposal. *Solid Wastes Management/Refuse Removal Journal*, 11(10):68, Oct. 1968.

The City of Maryville, Blount County, and the City of Alcoa embarked in 1962 on a cooperative arrangement under Tennessee's Interlocal Cooperation Act to operate a joint sanitary disposal area. The landfill is covered daily (except for Sundays and holidays) to a depth sufficient to eliminate nuisance odors. Salvaging, scavenging, and burning waste at

the disposal site are prohibited. Although the agreement may be terminated by any of the parties upon 6 months notice, it has continued without interruption in operation throughout the entire period.

68-1154

U.S. Department of Health, Education, and Welfare. Analysis of Well Water, 1968. 2 p.

In connection with a sanitary landfill used for research purposes in Ohio, it was noticed by the Field Development Projects personnel that there was a slight rise in the sulfate and chloride content of the water obtained from a well located approximately 500 ft from the landfill. The chloride and sulfate contents of some of the wells in this area were determined at intervals as an indicator of possible seepage from the landfill. The analyses were performed in duplicate according to Standard Methods for the Examination of Water and Wastewater, and the averages are reported. The results for both chloride and sulfate concentrations are within the expected normal ranges for groundwater in the area. Although slight changes were noted, no trend could be specifically established by the small number of determinations.

68-1155

Wuhrmann, K. Controlled unloading of waste. *Ingegneria Sanitaria*, 16(6):439-444, Nov.-Dec. 1968.

Discharge of wastes under controlled conditions avoid inconveniences such as smoke, bad odors, subsoil water pollution, and insect development. Various types of waste such as urban refuse, industrial residues, and slag should be disposed of under controlled conditions. The location of the landfill should be designed to keep to a minimum water contamination, air pollution, and breeding and feeding of rats and birds. Waste collection centers and their access roads should be kept clean in order not to devalue the surroundings. Several systems exist for the proper landfill of wastes. In some cases, the refuse has to be covered with material derived from the ground itself; in other cases, the waste itself can be used as the covering material. Some of the most important variables to consider in filling in ground with various types of waste are the slope of the ground and its soil composition. During the operation, part of the refuse is immediately compacted and covered up either by means of tractors or pneumatic equipment in order to avoid contamination of the surroundings. Physical or chemical changes occurring during landfill operations are under study, but few difficulties seem to arise when the landfill is properly managed. The cost of sanitary landfill at given collection centers for 8,000 tons is given as 14.3 Sw Fr per ton. In the United States, similar cost figures for 20,000 to 200,000 tons vary from 10 to 15 Sw Fr per ton. (Text in Italian)

STREET CLEANING

68-1156

Brown, L. More about litterbugs. *Missouri Conservationist*, 29(4):15, Apr. 1968.

The ugliness of a scenic Ozarks spot after visitors discarded trash and painted on rocks is graphically described. Annual

Street Cleaning

damage in national forests is \$5 million. Cleaning up streets, highways, and beaches costs nearly \$1 billion per year. Industry could help by paying for research and the development of beer cans that would melt away after a while out in the open and cigarette packages that would dissolve in the rain. States could institute large fines for littering. It is suggested that the Yellowstone, Yosemite, Grand Canyon, and Ozarks National Parks be closed and guarded by an army patrol in order to preserve some part of the country not yet buried in garbage.

68-1157

Costs \$25,000,000 yearly to remove highway litter. Public Health News, 49(3):47, Mar. 1968.

The National Litter Index, published annually by Keep America Beautiful, Inc., now stands at 109.6 for 1967 which is up about 3.3 points over 1966. The Index is compiled from vehicle miles traveled on primary State highways and the annual cost of cleaning up litter from these same thoroughfares. Rising costs for highway cleanup have also increased about 3.3 percent and vehicle miles traveled were up more than 5 percent. This means that litter fighters are holding their own, and there is a growing public awareness of the problems.

68-1158

Fleming, R. R. How to improve sweeping productivity. American City, 83(6):102-104, June 1968.

In quest of more economical street cleaning, city officials are purchasing sweepers with larger hoppers, speeding up debris disposal, and switching to long-lasting steel or plastic broom fiber. Hopper sizes of sweepers in use average about 3 1/2 cu yd, according to a survey. Some officials wish to sweep the freeways at speeds approaching those of traffic, while some insist that sweeping quality disappears at any speed over 15 mph. Several firms now manufacture the faster four-wheel, truck-type sweepers. Some municipalities have reduced the equipment and manpower required by adding an over-the-cab loader to their dump trucks. Others are converting to trucks equipped with LoDal loaders to pick up the refuse dumped on the street by the sweeper. This costs only a fraction of the price of an elaborate removable-hopper system with 'lugger' and 'mother' trucks. A sophisticated loading method of this type employs a vacuum truck. The cost of picking up sweepings, using this method, dropped from \$7 per cu yd to about \$2. Newest of the loading devices is a sweeper which projects its loaded hopper upward and outward to dump its contents directly into a truck box. Street officials report 180 to 280 miles of sweeping with brooms of natural fibers, while plastic brooms deliver 1,100 to 1,900 miles. Recording devices, created especially for mechanical sweepers, have aided in record keeping and efficiency of sweeping crews.

68-1159

Fox, N. A. Street sweeping-methods and incentive. Public Cleansing, 58(2):87-88, Feb. 1968.

Suction sweepers were needed for cleaning public roads, to replace the mechanical sweepers which had many disadvantages. The work load applicable to the sweepers was decided upon after testing. Extensive work-study

experimentation was expanded to discover the most efficient routing of the machines so that shopping centers would be cleaned daily, and main roads cleaned at regular intervals. The experiments and conditions are detailed. The scheme has been working long enough to show an improved standard of cleansing, and a saving of money.

68-1160

Gannon, T. H. Central control and L.D.P.. American City, 83(2):94-96, Feb. 1968.

Through the application of logistics and electronic data processing, Nassau County, New York, achieved the optimum in street sanitation, maintenance, and repair. The Highway Department is responsible for the cleaning, maintenance, and repair of approximately 500 miles of roads and streets, serving an area of 274 sq miles and a population of 1,500,000 persons. There is a work force of between 450 to 500 men and more than 700 major pieces of equipment from trucks, cranes, street sweepers, and tractors to pumps and compressors. To correlate the activities of the various areas, an operations control center was established at the garage housing the department offices. In addition to work assignments, each area reports data on the various jobs such as man-hours, personnel cost, vehicle cost, and materials and supplies. At present, the system can provide: a cost accounting and budgeting control system; a personnel data system; payroll preparation; and work accomplishment reports. Savings, through increased efficiency of work crews, will be analyzed on a seasonal basis.

68-1161

Mazowiecki, A. W. A big truck and a little sweeper. American City, 83(3):104-106, Mar. 1968.

The City of Clifton, New Jersey, population 93,000, which has a 12-sq mile area, has leaf-disposal problems in fall. Until 1966, the leaves were hauled to dumping sites located 10 to 14 miles away, causing tie-ups of equipment and large expenditures. In the fall of 1966, a temporary site was found within the city, but it also meant that the leaves had to be transferred to a final disposal site later in the year at a cost of about \$18,336. In the fall of 1967, the leaves were hauled to the final disposal site as they were being collected, using a Garwood T-100 and one of the Nelson loaders to load from a ramp at the city garage. The T-100 can take all the leaves the eight collection trucks bring to the transfer site in one trip. Using this system, the savings per year is estimated to be \$13,560. At this rate, the T-100 will pay for itself in less than 3 years on leaf collection alone. During the 'clean up week' in each spring, the T-100 is used to crush such materials as washing machines, refrigerators, mattresses, springs, old lumber, and bulky furniture through the use of the crushing action of the packer plate.

68-1162

A new method of removing dirt. Staedtehygiene, 19(6):7, June 1968.

A new unit closes the gap between the broom and the motor driven sweeping machines. It is called HAKO-FLIPPER. Wide use for this new unit is in workshops and storage rooms, in

courtyards, and on ramps, paths, and squares. It is useful everywhere a simple solution to the dirt problem is sought, but where it is neither feasible nor economical to keep a motor-driven sweeping machine. The new unit is a small, flat, and maneuverable manual brushing machine which is pushed in front of you. No force need be applied. It is small enough to be used for sweeping underneath furniture. The stable steel sheet casing contains a roller brush with plastic bristles and a 40 liter container to receive the dirt. A brush at the side makes it possible to remove dirt along edges and walls. With this side brush a strip 65 cm wide is cleaned. Without the side brush, the strip swept is 48 cm wide. Under normal conditions about 1,500 to 2,000 sq m can be swept per hour without any strain. To brush the same area with a broom would take about 5 hrs. Since no dust is stirred up and no waste gas arises, the new brushing machine is especially suited for rooms where food is stored or goods sensitive to odors. The machine is noiseless, so no one is disturbed. The machine picks up not only dust and sand but also scraps of paper, broken pieces of glass, and cigarette butts. It sweeps when pushed forward or backward; however, the rotating direction of the brush does not change. The pressure of the center as well as of the side brush on the floor can be adjusted. The container can be easily removed and inserted again. A sturdy steel frame protects the casing on all sides. (Text in German)

68-1163

Public Opinion Surveys, Inc. Who litters—and why; summary of survey findings concerning public awareness and concern about the problem of litter. New York, Keep America Beautiful, Inc., Nov. 1968. 14 p.

The main object of this study was to shed further light on three basic questions: who litters; why people litter; and the most effective way to deal with this problem. The survey reported was based upon two nationwide samples of adults, drawn in accord with proven sampling principles. The interviewing was done during the months of July and August, 1968. A behaviorist approach was deemed best in searching out those persons in the general adult population who are most inclined to litter. Littering practices of adults between the ages of 21 to 35 are more than three times greater than those of persons over 50, and nearly twice those in the age bracket of 35 to 49. Men are more guilty of littering than women. Households with only one or two persons litter significantly less than those made up of five or more persons. Farmers and residents of the smallest communities are more likely to litter than residents of the biggest cities—a finding that may reflect time out of doors, and lack of law enforcement. Reasons for littering given during the survey fall into two categories: carelessness, laziness, and indifference; and no trash receptacle available. The findings point to the fact that most littering practices are not regarded as very important—something a person ought not to do, but not too serious if he does it. Fifty-six percent of those interviewed said that there were public litter containers in their communities, but only 21 percent said there were enough.

68-1164

Street cleaning Scarsdale. Public Works. 99(3):116, Mar. 1968.

Mechanical sweepers are used in street cleaning operations in Scarsdale, N. Y. In the past fiscal year, 5,560 cu yd of silt,

sand, leaves, and debris were removed from the paved surface of 59 miles of curbed public streets. Village forces removed 152 loads of leaves, equal to 2,124 cu yd pulverized or 6,373 yd of whole leaves, using Tarco and Egan leaf loaders. Also four loads of leaves (18 cu yd) were removed from highways by mechanical sweepers.

68-1165

A street cleansing experiment. Public Cleansing, 58(5):241, May 1968.

Sunderland's Cleansing Committee authorized experiments to be carried out in an effort to provide five villages, which came into the borough, with a standard of service similar to that enjoyed in Sunderland itself. Main road cleansing is still carried out by a full-size vacuum sweeper, but the use of a New Era Sweeper was decided upon for other areas, not suitable for mechanical sweeping by large machines. The design of the smaller sweeper allows the operator to carry out normal footpath cleansing operations in village shopping areas and near bus stops. The small sweeper has a hopper capacity of approximately 14 cu ft, with an additional hopper positioned to give easy access for the contents of litter bins which may be picked up manually.

68-1166

Weisflog, W. E. Small sweeper-collectors. Public Cleansing, 58(11):561-571, Nov. 1968.

Small sweepers-cleaners for cleaning footpaths and pedestrian malls and parks are considered. Eleven models from various manufacturers are tabulated. Such information as payload, sweeping width, engine, speed, water tank, wheels, price, size, and weight is included. Five of these models are pictured and their design benefits discussed.

TRAINING, EDUCATION, AND PUBLIC RELATIONS

68-1167

Bogue, D., and R. J. Boston. Solid waste disposal—a new area of pollution. Georgia Municipal Journal, 18(2):14-15, Feb. 1968.

Georgia's problems in solid waste disposal are being studied by the Georgia Department of Public Health's General Engineering-Sanitation Service. A Solid Waste Planning Grant was obtained to study 36 counties and 107 communities. Industrial and commercial wastes are disposed of by various means; some pose hazards with little control or regulation by authorities. Opportunities and challenges offered by Georgia's solid waste problems include: (1) development of regional systems; and (2) the field testing and demonstration of new solid waste disposal techniques. Grant support available to States under the Solid Waste Disposal Act of 1965 is discussed.

68-1168

British composting firm gets research group backing. Compost Science, 9(1):29-30, Spring 1968.

Much publicity was given early in 1968 to a composting system developed by the Wolverhampton firm, Lawden

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Manufacturing Co. of England. The Lawden Co. reports that its methods require no human labor to sort out metal, plastic, and glass refuse before the composting process begins. The high speed shredder is said to accept anything that might turn up in a refuse truck, even a refrigerator, a mattress, a sofa, or an armchair, and shreds it to pieces as small as 6 to 8 in. After digesting in special digesters, the composted material is fed to a separation process in which metallic pieces like tin cans are removed, and other larger pieces of material, which are not acceptable in the final process, are sorted out by a coarse screen. The resulting material is fed into a 300 horsepower grinding machine. Three new products are created as a result of this operation and these are described. Questions have been raised as to the validity of the claims, since no pilot plant has actually been built and no compost or fertilizer has been produced as yet. Its inventors say that any small scale test is not feasible, but that all components have been amply tested. Other writers in British journals point out that no market research has been done on the acceptability of the product or the price—a consideration on which the entire operation may succeed or fail.

8-116

Clemons, C. A., and R. J. Black. Summaries of solid wastes program contracts, July 1, 1965-June 30, 1968. Public Health Service Publication No. 1897. Washington, U.S. Government Printing Office, 1969. 46 p.

Coupled with its supplement, this publication summarizes the 53 contracts funded and conducted under the auspices of the Solid Waste Disposal Act of 1965. These investigative activities cover the time period July 1, 1965 through June 30, 1969. Research contracts are conducted as a separate operation within the Bureau of Solid Waste Management to implement the directed research efforts of the Solid Waste Disposal Act; the rapidly developing field of solid waste management offers to both governmental and business personnel a wide variety of subjects to be studied, ranging from appraisals of current solid waste practices in Western Europe to the development of a model solid waste management ordinance and a digest of existing ordinances. The contract summaries are arranged alphabetically by contractor and present the objectives, the approach used, a summary of progress, and publications resulting from each project. Additional information given includes the cost of the contract, commencement and termination dates, and the project director.

68-1170

Ford Foundation grants in resources and environment. New York, Ford Foundation, June 1968. 22 p.

The Ford Foundation has been engaged in an enlarged program of natural resource preservation and management since 1964. In its broadest terms, the focus of this enlarged Foundation program is the perception of, the concern over, and the effort to do something about problems that arise out of conflict between man's need and capacity to engineer his environment for economic use, and the need and capacity of natural systems to adjust to the consequences. The Foundation has been especially responsive to the scientific need for natural areas to study and it has helped a few other institutions acquire some. On two occasions the Foundation made grants simply for land preservation without direct ties

to scientific use. To encourage basic science and spotlight its importance, grants totalling \$1,408,000 were made to Princeton and Chicago in support of expanded graduate programs in ecology and population biology. Other grants in this area aim at encouraging ecological training for those more directly concerned with problems of managing resources. The Foundation's major programmatic interests now are: selective support on a reduced scale for training and research in environmental sciences; sharpening of legal tools for conservation; and continued exploration of the possibilities of effective environmental education at the primary-secondary level. A comprehensive list of grants is given.

68-1171

Furman, T. deS. University of Florida graduate program in solid wastes. In Engineering Foundation Research Conference; Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint G-5.)

The master's degree program in Environmental Engineering at the University of Florida is divided into seven areas: air pollution; aquatic biology; radiological health; solid wastes; water quality management; water treatment and distribution; and wastewater treatment and disposal. All students are required to take courses in environmental biology, chemistry, and statistics. Three courses in solid wastes cover quantities and characteristics of municipal refuse, analysis of solid wastes, and design of disposal facilities. The recently completed Gainesville compost facility is also available for instruction and research.

68-1172

Glysson, E. A. University of Michigan, solid wastes engineering training program. In Engineering Foundation Research Conference; Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint G-3.)

Courses offered by the Civil Engineering Department of the University of Michigan for a M.S. degree include: two courses in Solid Wastes Engineering; Microbiology; Applied Chemistry of Water and Waste Water; Land Utilization and Planning; Air Pollution; Environmental Systems Analysis; Management; and Statistics. In addition, there are other elective courses in Political Sciences, Business Administration, and Industrial Engineering. Some limited research studies that have been undertaken are: characteristics of refuse incinerator residue and incinerator quenching waters; time and motion studies of refuse collection; and evaluation of energy expended by refuse collectors.

68-1173

Golueke, C. G., and P. H. McGauhey. Comprehensive studies of solid wastes management. In Engineering Foundation Research Conference; Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint F-7.)

The objectives of the study are to develop solutions to solid waste problems through research, to develop an understanding of management problems on the part of

engineers, administrators, and other specialists, and to relate research to real problems. A survey in the Public Health field is being made of those components in the waste stream which pose potential health hazards, such as asbestos, beryllium, cadmium, heavy metals, and biological vectors. Work was begun on a mathematical model for waste generation, and a study of the variation in solid waste generation will use the San Francisco Bay area as the test area. Active research is in progress in the study of: pyrolysis; anaerobic digestion of green garbage, paper, wood chips, and chicken manure; wet oxidation; biofractionation studies concerned with converting cellulose to useful material by microbial action; and composting studies in relation to storage and fertilization of land.

68-1174

Malina, J. F. Solid wastes training at the University of Texas at Austin. In *Engineering Foundation Research Conference; Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint G-4.)

The solid wastes training program at the University of Texas Environmental Health Engineering in the Civil Engineering Department. A new multidisciplinary course has been developed to include the qualitative and quantitative characterization of solid wastes from various sources, and currently applied and new processes of solid waste disposal. Core courses provide the student with a fundamental background. A thesis dealing with some aspect of solid wastes production, collection, and disposal is required for the degree.

68-1175

Metz, G. L. E. Investment grants and the scrap processor. *Materials Reclamation Weekly*, 113 (22):15-18, Nov. 30, 1968.

Investment grants operated by the Board of Trade under Part I of the Industrial Development Act, 1966, are among a series of incentives provided by government to encourage modernization, productivity, efficiency, and investment in manufacturing industries. The British Secondary Metals Association and the Federation of Reclamation Industries are trying to persuade the Board of Trade that scrap processing qualifies for these grants, because it is concerned with the making of an article. Some scrap processors have applied for these grants for expenditure on new plants and have gotten them. Others have entered into commitments for the purchase of a new plant, only to find that the Board of Trade does not now regard this as eligible for a grant, since it does not now regard the making of prepared scrap as the making of an article. The Board of Trade takes the view that the efforts involved in scrap processing, such as in the conversion of an old car into scrap, are not sufficiently great to justify payment of investment grants on the machinery needed. It is hoped that this question will be re-examined, and steps taken to remove the feeling that the industry has received less than justice.

68-1176

Pohland, F. G., and J. D. Westfield. A graduate solid waste training program. In *Engineering Foundation Research Conference; Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint G-2.)

Georgia Institute of Technology's program for a M.S. degree in Solid Waste Technology consists of a core curriculum administered by the schools of: Civil, Industrial, and Mechanical Engineering; Architecture and City Planning; and Applied Biology and the Department of Social Sciences. With the exception of two new graduate courses in Solid Waste Technology, the core curriculum consists of courses which were available at the inception of the program. These courses include: statistics, systems analysis, operations research, community planning, sanitary engineering, and environmental health. Formal instruction is complemented by laboratory experiments and demonstrations, occasional field problems, visits to existing facilities, and seminars.

68-1177

Purdom, P. W. Drexel Institute of Technology graduate program in solid wastes technology. In *Engineering Research Conference; Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint G-1.)

Supported in part by a training grant for the Public Health Service, a graduate environmental program at Drexel Institute of Technology leads to either an M.S. or Ph.D. degree. The graduate work emphasizes urban problems and includes such courses as: environmental health; environmental chemistry; sanitary microbiology; hydrology; solid wastes technology; systems and analysis; combustion theory; and administration and statistics. Research on which students are currently working include: incinerator residue quality, leaching from incinerator residue, and groundwater pollution from sanitary landfills.

68-1178

Schaub, J. H., and R. Zaltzman. A graduate program in solid wastes at the West Virginia University 1967-1968. In *Engineering Foundation Research Conference; Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint G-6.)

A solid wastes training program, offering both master's and doctoral degrees, was established within the Department of Civil Engineering at West Virginia University as part of the overall emphasis on environmental engineering. A laboratory with specialized instrumentation is being built and equipped for the solid wastes program. Specific courses in solid wastes cover: traditional patterns and problems; municipal and industrial design of disposal operations; design of dynamic material systems; and advanced work in analysis and design. Related courses cover public health engineering, air pollution control, sanitary chemistry and biology, radiological health, engineering statistics, municipal government, and ecology.

68-1179

Shuster, W. W. Solid wastes engineering. In *Engineering Foundation Research Conference; Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint G-7.)

The program leading to the master's degree at Rensselaer Polytechnic Institute provides the opportunity for study in Environmental Engineering, with particular emphasis in the area of Solid Wastes Disposal. Courses which emphasize solid wastes include: the unit processes in environmental

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engineering; atmospheric pollution; management and planning for pollution abatement; public health; environmental engineering solid wastes laboratory; and thesis projects. Other courses cover microbiology, water resources, ground water geology, industrial waste treatment and disposal, and mathematical models of operation research.

68-1180

Steigman, H. Solid waste disposal. *Pennsylvania's Health*, 29(2):8-12, Summer 1968.

Under the Solid Waste Disposal Act of 1965, Pennsylvania received a \$315,441 Federal grant to launch a 3-year study which will result in a plant for a sound solid waste management program. A Solid Wastes Unit was set up under the Sanitation Division's Environmental Development section. Pennsylvania adopted the data inventory forms for solid waste studies which were developed by the National Task Force Committee, and it was the first State to use the U.S. Public Health Service's data processing facilities to compile information from these forms. The State's 2,559 municipalities have provided information on a 'Community Description Report' which covers all phases of administration, enforcement, and costs relating to solid waste programs. The 'Facility Investigation Report' is designed to gather material about permanent disposal installations, and the 'Land Disposal Site Investigation Report' seeks to provide detailed information on landfills and dumps. Also, a random sampling of 13 percent of the Commonwealth's industries covering wastes, volumes, special handling, salvage ability, and disposal techniques is underway, and a similar sampling of the State's farms is planned. Several universities are cooperating in studies including: laboratory determination of the processes which occur in the interior of a sanitary landfill; utilization of incinerator residue as a cover for landfills; and transporting solid wastes through pipelines. Legislation is proposed to set up joint responsibility by State and local municipal government for planning and enforcing a solid waste program.

68-1181

Twenty-three solid waste demonstration projects underway. *APWA Reporter*, 35(1):8-9, Jan. 1968.

A total of 23 solid wastes disposal demonstration projects are now underway, according to a recent report from the National Center for Urban and Industrial Health. The Center has awarded grants totaling \$2,492,399 for the experiments with new disposal techniques or more adequate disposal programs. Summaries of the projects are given in this article, with the names of the project directors. Complete information is available from Mr. Richard D. Vaughan, Chief of the Solid Wastes Program, N.C.U.I.H. Some of the projects include: developing better methods of auto salvage; designing and constructing pollution-free incinerators; and studying the effectiveness of regional solid waste management.

68-1182

Vaughan, R. D., and R. J. Black. The federal solid wastes program. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.318-321.

Significant developments in the field of solid waste disposal since 1966 are reviewed. The subject of solid wastes has been

examined in detail for the first time by four top level scientific and advisory groups: the Committee on Pollution of the National Academy of Sciences-National Research Council; the Environmental Pollution Panel of the President's Science Advisory Committee; the National Commission on Technology, Automation, and Economic Progress; and the Task Force on Environmental Health and Related Problems. Thirty-six States have received grants for making Statewide surveys of solid waste needs and comprehensive plans for meeting them. Total funds awarded by the Public Health Service for state planning grants during Fiscal Years 1966 and 1967 amounted to almost \$14 million. Fifty-three public agencies or nonprofit institutions have received demonstration grants covering up to two-thirds of the cost for studies and investigations of more systematic approaches to solid waste disposal. Total funds awarded for demonstration grants during Fiscal Years 1966 and 1967 amounted to almost \$7 million. Eight institutions of higher learning have received grants totaling \$490,000 to support the training of graduate students in engineering, the physical sciences, economics, and other disciplines. About 300 design, operating, and administrative personnel from government and industry subscribed to four solid waste training courses. New research facilities have been completed at Johnson City, Tennessee, and Cincinnati, Ohio. The Solid Wastes Program has used the contract mechanism to augment staff capabilities.

68-1183

Weber, C. E. Experience in conducting an incinerator technology course. In *Proceedings: 1968 National Incinerator Conference*, New York, May 5-8, 1968. American Society of Mechanical Engineers, p.322-326.

The Incinerator Committee of the American Society of Mechanical Engineers organized and sponsored a course in 1966 and 1967 for public officials, incinerator operators, and managers. The course is outlined, and enrollment and other factors which contributed to its success are discussed. The basic philosophy of the course was to teach the underlying principles and basics that are not acquired by experience alone, and to provide understanding of plant phenomena to guide in decision making. The course consisted of a series of fifteen lectures entitled: Incinerator Terminology; Refuse, Residue, and Air: Combustion and Heat; Pressure, Draft, and Flow of Gases; Maintenance and Inspection; Air Pollution Control; Instrumentation; Refractories and Metals; Hydraulics; Mechanical and Electrical Systems; Disposal of Flyash and Residue; Stokers and Grate Operation; Incineration of Bulky Refuse; Public Relations and Personnel; and Modern Concepts Here and Abroad. Lectures on the subject of uses of recovered heat, public relations, record keeping, and safety, presented during the first course, were combined with other lectures for a second course. Recommendations are offered to assist others in the planning of future courses.

68-1184

World Health Organization (Official Records) No. 172. Environmental health, chap.7. Geneva, 1968, p.57-63.

In many developing countries, the rate of urbanization is so great that waste-water collection, treatment, and disposal lag far behind community needs, and the construction of the urgently required sewage systems and treatment plants for

major cities are constantly deferred because of the high capital costs. WHO is therefore assisting an increasing number of developing countries in the preparation of requests to the United Nations Development Program for financing, from the Special Fund component, of the necessary preinvestment and engineering feasibility studies for economic long term waste disposal programs, particularly for capital cities and other large communities. Studies carried out by consulting engineering firms under WHO supervision serve as a basis for securing from international sources the loans essential for the implementation of the long term waste management plans. Progress in the preparation of a master plan for a sewage and solid waste collection and disposal system for these metropolitan areas are briefly discussed: Manila, Taipei, Ibadan, Teheran, Central African Republic, Greater Kuala Lumpur, Ipoh, Bangkok, Government of Iran, Government of Fiji, Manila, Israel, India, and the United States. The WHO International Reference Centre on Wastes Disposal was set up in September 1968 at the Federal Institute for Water Supply, Sewage Purification and Water Pollution Control, Zurich, Switzerland, to establish an international program for the collection, storage, and distribution of information.

MANAGEMENT

68-1185

Anderson, L. E. Comprehensive studies of solid wastes management: a mathematical model for the optimization of a waste management system. Berkeley, University of California, Feb. 1968. 63 p.

The complexity and magnitude of the flow systems needed in wastes management are such that the 'systems analysis' approach is indicated. Moreover, the type of complex interrelationships involved in flow systems are well suited to such an approach, especially since it leads to the development of mathematical models, the tools with which such systems can be most readily optimized. The aim of the research is to develop a general procedure for shipping, at minimum cost, within the limits of arc and activity capacities, all wastes from their source to sink by way of intermediate points as required. The specific problem of transporting solid wastes from communal transfer stations via transfer vehicles was examined. An algorithm was developed which makes use of the combinatorial structure of this transportation problem, and an optimal shipping schedule subject to aggregate flow restrictions and arc and sink capacity restraints was obtained. A simulation was made of the general problem of transporting and treating all wastes generated in a typical community. The system was optimized by applying a parametric, out-of-kilter, linear programming procedure. While the system thus developed was in general a multicommodity network flow problem, the consequent limitations were avoided by incorporating fixed ratio flow dividers to segregate commodities, and to allow optimization by conventional methods. Numerous equations, flow charts, and illustrations of the system are given.

68-1186

Armstrong, D. H. Airborne pathogens associated with solid wastes handling. In Engineering Foundation Research Conference: Solid Waste Research and Development, II, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint C-10.)

Municipal refuse handling operations constitute a health hazard, since the dust generated carries a large number of microorganisms, including pathogens of intestinal and respiratory tract origin. The degree of hazard depends on the concentrations of the dust and the types of organisms associated with the dust. A qualitative and quantitative study was made by the Solid Wastes Program of the microbiological flora of the dust associated with four municipal refuse incinerators and a composting plant. Air samples were taken with an Anderson volumetric sampler used in conjunction with TSA blood agar and eosin methylene blue agar plates. The results, as reflected by the isolation of pathogens, indicate that the potential health hazard from the dust is significant.

68-1187

Bower, B. T., G. P. Larson, A. Michaels, et al. Waste management: generation and disposal of solid, liquid and gaseous wastes in the New York region; a report of the second regional plan. New York, Regional Plan Association, Inc., Mar. 1968. 107 p.

The waste situation in the New York area is reviewed. The present sources of waste, their interrelationships, and the types of waste are considered. The environment's assimilative capacity and the effects of waste discharged to it are examined. The present sources and amounts of wastes are reviewed, and these figures are used to predict the wastes to the year 2000, considering various alternatives of management and regulation. Suggestions are made for regional planning and the costs attendant on the management choices. The appendix lists the present management costs, the assumptions used in developing the predictions to the year 2000, and the background data used in preparing the estimation of the present situation. Tabulated data cover: paper consumption, vehicle-miles per business day present and projected, particulate emission level v. incinerator costs, and the relationship between sulfur dioxide concentration and damages. Maps of the study area and the filled wetlands over the past half century are included. All the data used in formulating the data coefficients are listed in tables in the appendix. These include various population predictions based on living patterns, and different categories of waste generation by industry.

68-1188

Bower, B. T., G. P. Larson, and A. Michaels, et al. Introduction. In Waste management: generation and disposal of solid, liquid and gaseous wastes in the New York region; a report of the second regional plan. New York, Regional Plan Association, Inc., Mar. 1968. p.13-22.

This study is concerned with a 31-county region around New York City. It specifies procedures by which the problems of wastes generation and management can be incorporated in regional planning. It also examines the impact of settlement patterns on generation of wastes, and indicates the impact of different waste management policies on waste generation, environmental quality, and costs. Lists on the types of data needed for the analysis of waste management in the region are included. The assimilative capacity of the environment is considered. Programs might be initiated whereby incentives are offered to industries to reduce wastes whether by taxing their effluents, or by paying part of the money saved in

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treatment costs back to the manufacturer reusing the waste. The percentage of waste paper utilized in new paper production has fallen to 20 percent, but if it were increased to 80 percent, it would save the New York area 100 million dollars per year in waste treatment costs.

68-1189

Bower, B. T., G. P. Larson, A. Michaels, et al. underlying concepts and principles. *In* Waste management; generation and disposal of solid, liquid and gaseous wastes in the New York region; a report of the second regional plan. New York, Regional Plan Association, Inc., Mar. 1968. p.23-35.

A waste management system consists of: (1) facilities for handling, treating, and disposing of waste; (2) facilities for modifying the assimilative capacity of the environment; (3) regulations for modifying the generation and discharge of wastes; and (4) facilities and procedures for collection and analysis of data necessary in monitoring environmental quality and the performance of individual waste generators and waste reduction facilities. The basic problems in handling various types of wastes involve determining the impact of waste discharges on the quality of the environment, and determining the effects of the temporal variations in the concentrations of the wastes. Waste management involves the regulation of discharges from points of waste generation and from collective waste-handling facilities. Three types of standards can be applied: raw material standards, discharge standards, and ambient standards. The quality of air, water, and land, when affected by the discharge of wastes, can be modified or improved in three ways: (1) by reducing the generation of wastes; (2) by reducing, in on-site and/or collective facilities, the quantity of wastes discharged after generation; and (3) by modifying the assimilative capacity of the environment or making better use of the existing assimilative capacity.

68-1190

Bower, B. T., G. P. Larson, A. Michaels, et al. Waste generation: present and future. *In* Waste management; generation and disposal of solid, liquid and gaseous wastes in the New York region; a report of the second regional plan. New York, Regional Plan Association, Inc., Mar. 1968. p.37-44.

The economic data for this study consisted of the Regional Plan Association's population and employment projections to the year 2000. These projections were made for sub-areas of the region according to Standard Industrial Classification categories. Two kinds of wastes are given special attention: the abandoned or junked vehicle, and radioactive wastes. In developing the analysis four major factors were considered: (1) the technology of production processes; (2) product mix; (3) the type of raw material inputs; and (4) the controls on waste discharge. The costs of waste management include such items as annual charges on the investment in on-site and collective waste reduction facilities, operation and maintenance costs for these facilities, cost of land for landfill, effluent charges, paid capital, and O&M costs of quality monitoring networks, and costs of performance checking. The impact of waste discharges must be assessed. This requires the development of mathematical models which interrelate the variables. The effluent control policies adopted by the relevant governmental agencies are part of the

waste management system.

68-1191

Bower, B. T., G. P. Larson, A. Michaels, et al. Waste generation: present and future. *In* Waste management; generation and disposal of solid, liquid and gaseous wastes in the New York region; a report of the second regional plan. New York, Regional Plan Association, Inc., Mar. 1968. p.45-51.

Based on population, employment, the number of vehicle-miles that were traveled and fossil fuel consumption estimates can be made on the present levels of solid waste. Estimating future waste generation levels is much more complicated. Changes in packaging modes and household heating practices have caused large variations in the amount and types of wastes in recent years, and these changes can be expected to continue. The gross amounts of solid household wastes have been increasing at a rate of over 2 percent per year due to the increasing use of disposable containers. Two different projections are made to the year 2000. The first assumes that the present trends continue in waste generation and disposal, but the second assumes that policies, regulations, and/or incentives will be established so that the per capita generation of solid wastes will level off at present amounts. Incentives on the industrial level can be provided by charging for quantities of BOD discharged and/or for water intakes. These charges might make it economically favorable to construct water treatment and recirculation systems. The total amounts of solid wastes, as opposed to gaseous and liquid wastes, that will have to be disposed of by landfill are also estimated. These considerations show the need to form incineration and salvage operations.

68-1192

Bower, B. T., G. P. Larson, A. Michaels, et al. Waste management methods and residual waste discharged: present and future. *In* Waste management; generation and disposal of solid, liquid, and gaseous wastes in the New York region; a report of the second regional plan. New York, Regional Plan Association, Inc., Mar. 1968. p.53-66.

Present and alternative future waste management methods and related estimates of residual wastes discharged to the environment are discussed. Five types of wastes are considered. BOD wastes are largely removed at municipal and industrial sources. Hydrocarbons are partially removed at the refineries, but the absence of emission control is responsible for increases due to rising automobile use. Sulfur dioxide is discharged into the atmosphere by fossil fuel heating plants. Particulates come from industries, power plants, automobiles, and incinerators. Solid wastes are principally disposed of by sanitary landfill, although hog feeding is still used for restaurant wastes. Many possible alternatives are available for handling wastes which incorporate different combinations of on-site and collective methods, and different combinations of 'sinks' for final disposal. The various management conditions also involve policy decisions. An example of this is the control of exhaust emissions. Tables list the management conditions projected for the year 2000, some of the other possible management conditions, the amounts of each type of waste discharged in 2000 given various management variations, and the hydrocarbon emission projection based on various cases.

68-1193

Bower, B. T., G. P. Larson, A. Michaels, et al. Implications for governmental organization. In *Waste management: generation and disposal of solid, liquid and gaseous wastes in the New York region: a report of the second regional plan*. New York, Regional Plan Association, Inc., Mar. 1968. p.67-71.

This report shows that a thorough study of the present procedures of governmental organization in waste management is necessary. Only in recent years has the concept of comprehensive waste management systems evolved, and it has not yet been applied anywhere in the United States. An outline covering the waste management functions in relation to governmental organization in the New York area is presented. Two major questions to be investigated in the study are: (1) the extent to which the various relevant activities should be performed by a single overall regional agency; and (2) the extent to which activities relating to all three forms of wastes should be organizationally combined. In some cases, regional and subregional organization has advantages. Excessive centralization of administrative functions might make for more problems than it would solve.

68-1194

Bower, B. T., G. P. Larson, A. Michaels, et al. Summary and suggestions. In *Waste management: generation and disposal of solid, liquid and gaseous wastes in the New York region: a report of the second regional plan*. New York, Regional Plan Association, Inc., Mar. 1968. p.73-79.

Various suggestions relevant to the continuous appraisal of environment quality and waste management in the region are given. These are divided up into short run and long run suggestions. The former include: refine the analyses of waste management costs and disposal methods; inventory the areas and spaces available for land disposal of solid wastes within the region; and show how studies by other agencies can be incorporated into the waste management program. The long run suggestions include: the collection of detailed data on the waste discharges on air, water, and land quality; studies to see if areas are available where advantageous changes in topography could be made by landfilling. Various other studies are suggested to determine the efficiency of incineration methods, new waste collection systems, and the use of effluent charges. The ultimate disposal means would be an on-site system that would maximize recycling and minimize residue.

68-1195

Burgess, R. APWA Research Project 66-1: comparative public works statistics. In *American Public Works Association Yearbook 1968*. Chicago, American Public Works Association, p.190-207.

The Research Foundation of the American Public Works Association initiated a two-year research program on comparative public works statistics, under the financial sponsorship of some 32 cities and counties across the United States and Canada. The purpose of the project is to develop a system for collecting, analyzing, and reporting valid comparative public works statistics that will be useful to the several levels of supervisory, administrative, professional, executive, and policy-making officials in carrying out their

planning, programming, budgeting, controlling, and other decision making responsibilities. As used in the study, the term 'public works' includes all operation and maintenance activities associated with street, parks, water and sewage utilities, airfields, docks and harbors, public buildings, equipment, and refuse collection and disposal. The operations profile chart for residential refuse collection is illustrated. This kind of information will make it possible to determine optimum ways of performing public works operation and maintenance activities under a variety of conditions. Another chart shows the prevalency of various refuse collection methods such as curb pickup, rear yard pickup, and other collection methods. Other tables can show service levels, and other policies and practices.

68-1196

California State development plan program; phase II report. Sacramento, California State Office of Planning, 1968. 363 p.

The California State Office of Planning, plus other California agencies, departments, and divisions undertook to transmit the most significant development issues facing this rapidly growing State. The results are over one hundred recommendations for legislative and administrative action. The emphasis was upon furnishing the executive and legislative decision-makers at the State level with a reliable, consistent, and comprehensive body of information about statewide and regional development trends, issues, and potentials which can be utilized in setting development goals and in focusing policies and programs on their achievement.

68-1197

Clarkeson, J. Appendix I, Multi-use of land facilities. In *Summer study on the management of solid wastes; final report*. v.i. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. p.55-58.

One of the most pressing problems in solid waste disposal is to find available sites. Multiuse of land for many types of public purposes is feasible. Because of the width and location of large expressways, a study was made to determine to what extent such facilities may be used to serve the waste disposal problem. A study was made of the expressway land-takings in the Boston area of Massachusetts. Multiuse of elongated stretches of land such as are required for highways and power distribution facilities could serve other purposes. In the Boston area, 4,500 acres of land adjacent to the 104 miles of expressway are not being used for transport purposes and are, therefore, available. The existing system of expressways in this area will provide space, if properly handled, for more than 5 years of solid waste disposal used as sanitary landfill.

68-1198

Collins, L. Regional refuse disposal in the north east. *Public Cleansing*. 58(8):418-429 Aug. 1968.

Evidence was produced showing that a coordinated program of land reclamation was essential in the northeast area of England. Various proposals, including incineration, were considered, and regional cooperation in any program of refuse disposal was encouraged. After a thorough study of the needs and projections for the area to be served, a

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computer program was written to determine sites for incinerators. The recovery of derelict land was extended as an important feature, and problems in relation to refuse disposal in the area had to be organized in such manner that crude, pulverized, composted, or incinerated refuse could be utilized properly.

68-1199

Improving community solid waste practices through planning. Solid waste Publication 2. Harrisburg, Commonwealth of Pennsylvania, Department of Health, Dec. 1968. 28 p.

The topics of solid waste planning discussed are: What is Solid Waste; How Much Solid Waste; Why Is Solid Waste a Problem; Contemporary Solid Waste Disposal Methods; Number and Type of Disposal Sites in Pennsylvania; Need for Municipal Control of Solid Waste Practices, Uniform Standards--A must; A Sound Management System is Vital; Areas of Responsibility for Solid Waste Management; Solid Waste Planning; Major Operational Phases in Solid Waste Management; Land Requirements; Transportation Requirement; Disposal; Assistance; and a Regional Concept. The Appendix includes: Pennsylvania Statutes pertaining to solid waste, rules and regulations pertaining to solid waste, fact sheet on the Pennsylvania Solid Waste Management Act, summary of Act 421, solid waste materials--a list of examples, map of human service regions, listing of State health centers, and a listing of full-time local health departments.

68-1200

Proceedings; Governor's Conference on Solid Waste Management, Hershey, Pa., Oct. 8-9, 1968. Harrisburg, Pennsylvania Department of Health, Bureau of Housing and Environmental Control. 212 p.

The Governor's Conference on Solid Waste Management was the initial step in the implementation of the Pennsylvania Solid Waste Management Act. Through this Act, Pennsylvania became the first State in the U.S. to form a partnership with local government to plan and execute a good solid waste management program. The conference represents a cooperative attempt to present, discuss, and provide a basis for resolution of some of the difficult aspects of solid waste management. Representatives of government, industry, and consulting firms cover such topics as: Pennsylvania's program; government authority and responsibility; solid waste management; regional planning; industrial, institutional and agricultural wastes; engineering aspects of solid wastes handling; and approaches taken by various Pennsylvania communities to the solid waste problem. Reports to the Governor are included for each panel discussion held at the conference along with the questions and answers that accompanied each discussion. A list of program participants is appended.

68-1201

Culver, B. D., and T. E. Walsh. Some aspects of systems engineering for waste management in California. Archives of Environmental Health, 17(3):377-382, Sept. 1968.

The development of a method for providing a system designer with a rational basis for selecting the best

performance conditions with which to store, transport, process, or dispose of the wastes found in any subregion (municipal, interface, agricultural, or industrial) is described. Four tables were developed, giving a numerical coefficient for such bad effects as: flies rodents, crop damage, water pollution, odor safety hazards, human disease, etc., one for each subregion. The coefficient was arrived at through multiplication of a 'relative importance scale' developed for a region, and the 'relative contribution to these effects by solid wastes' scale. This was then normalized to give an 'influence coefficient.' The influence coefficients were used to relatively weigh the raw, bad effect scores on a region's basis through a straight multiplication process. The raw bad effect scores for a region are developed by scoring an effect from consensus data as compiled on 13 separate tables, one of which is illustrated. Tabulations include 'Bad Effects Contribution of a Waste under Various Conditions,' 'Subregional Categories,' 'Relative Importance of Bad Effects by Subregions,' 'Estimated Percent Contribution of Solid Wastes to Bad Effects by Subregion,' and 'Development of the Influence Coefficient of Bad Effects.'

68-1202

Dasmann, R. F. Solid wastes. In An environment fit for people. New York, The Public Affairs Committee, 1968. p.10-12.

The disposal of solid wastes has always presented a problem for mankind. No longer is the simple solution of burning garbage possible in most urban areas because of the air pollution danger that it involves. Some cities seek to fill in deep and unwanted canyons with their junk; others build artificial hills and cover them with soil; but the pile of rubbish grows ever higher, and the more advanced the technology, the greater the amount of garbage and solid waste. As with air and water pollution, one must look beyond the immediate measures--to the long term solution. This means reclamation and recirculation of the materials now tossed wastefully aside.

68-1203

El-Shaieb, A. Optimal activity locations. Operations Research Center Report 68-3 Berkeley, University of California, Feb. 1968. 96 p.

A branch and bound method is given for solving a given problem. The method is compared with other methods, and a practical application is given. A review of previous work, the single source problem, and multiple source problem are discussed. The problem can be summarized as follows: for a number of sources, given their locations, requirements, and associated shipping costs, the number of destinations their locations and capacities must be found. The main objective of the problem is to optimize the routing of shipments in multisource, multidestination systems. The formulated problem is mainly a nonlinear programming problem. Three algorithms are developed for the given problem. An enumeration algorithm and a branch and bound algorithm, each yields an optimal set of source locations. A heuristic algorithm which yields an optimal or near-optimal set of source locations, is discussed. A search procedure that converges to an optimal source location is presented. The search procedure is based on both the quadratic approximation and Fibonacci approximation, for which, an

outline is presented. Minimizing the total cost of transportation is considered. The cost of transporting one unit is proportional to the square of the distance traveled. It is concluded that the branch and bound method is superior to the exact method in terms of the number of nodes required. A ratio of one-half is found in the case of small-size problems; the ratio decreases to about one-third in the case of larger-size problems.

68-1204

Fisher, R. E. We put progress above politics... and solved a refuse-disposal problem for five adjoining municipalities. *American City*, 83(7):113-115, July 1968.

One of the first steps toward regional cooperation in the State College, Pennsylvania area consisted of establishing the Centre Regional Planning Commission. Its membership includes representatives from the Borough of State College and from four townships covering an area in excess of 130 sq miles with a population of more than 40,000. Agreements were made covering the use of the borough's sanitary landfill, between the five licensed private collectors and the five municipalities, establishing collection and disposal requirements. The uniform ordinance enacted by each participant included the following regulations: that property owners must patronize the licensed collectors; that a license covering a period of 1 year and costing \$1 is needed to handle solid wastes; that a license can be revoked upon failure of the contractor to comply with existing ordinances; the hauler must secure a performance bond and provide the townships with certificates of public liability insurance; and the hauler must dispose of the refuse only at approved sites. Materials potentially detrimental to health and safety are restricted from the landfill. Criteria were established for sharing costs. Through the first 8 months of operation, the cost of the landfill operation was approximately \$25,400. Wastes from the region averaged about 2,430 tons per month. Projected over a 12-month period, and with an estimated annual budget of \$40,000, the cost of disposal comes to about \$1.33 per ton.

68-1205

Forsberg, F. J. Inventory of the solid waste situation in Minnesota. Presented at Animal Waste Symposium, Minneapolis, Nov. 21, 1968. 10 p.

To cover the majority of Minnesota's population in regard to the solid waste situation, surveys were conducted of communities with populations of 5,000 and over. Based on 17 county surveys, which includes the Seven County Metropolitan Area, an average of 18.3 sites per county would mean that 1,590 dumpsites now exist in the State of Minnesota, of which 90 percent are open-burning dumps. To aid in correlating surveys nationally, the Department of Health, Education, and Welfare has developed three survey forms to identify the problem. First is a community description report to obtain information about size, organization for handling solid waste, refuse storage, collection and disposal along with amounts and costs. A landfill disposal site investigation report consists of disposal capabilities, costs and methods of operation. The facility investigation report provides information about operating characteristics and capabilities of all solid waste reduction or disposal facilities other than land disposal sites. The data

received are being computerized on punched cards to enable a development of a Statewide analysis. Of the preliminary findings, sanitary landfills numbered 182, 175 of which were substandard. Twelve percent of the sites were spreading and composting refuse in 2-ft layers or less. Estimates received from the 182 sites indicated that 443,050 tons or 10,006,330 cu yd were disposed of annually. Outside of the Seven County Metropolitan Area, 73 percent of the population practiced backyard burning. Other preliminary data were given.

68-1206

Hample, C. R. The national survey of community solid waste practices information systems. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York, p.F-3.

Under the Solid Waste Disposal Act of 1965, which provides for grants to State and interstate agencies for conducting surveys of solid waste disposal practices and for developing solid waste plans, data on disposal have been acquired on three different forms. The Systems and Operations Planning Activity of the Solid Waste Program acts as the central locale for the collection of the completed survey forms and for the processing of the information. A computer storage and retrieval system, which has six magnetic tape units available as auxiliary storage, was chosen. Each survey form is treated as one record and stored on magnetic tape. The retrieval activities of the system are restricted to retrieval of entire records. Additional retrieval capabilities are being developed to retrieve by population groupings and by response criteria for each question of the survey.

68-1207

Hickman, H. L. Planning comprehensive solid wastes management systems. *American Society of Civil Engineering, Journal of Sanitary Engineering Division*, 94(SA6):1147-1152, Dec. 1968.

Solid wastes have not received proper recognition as a national problem, and therefore, have not received thoughtful planning, design, careful operation, and strong public support. Planning must be approached by effective problem-solving teams. The areas which must be examined include: determination of population and economic growth in the study area; an evaluation of existing solid waste disposal systems; investigation of quantities of wastes generated by the system; and formation of a comprehensive public information plan. Finally, a well thought out implementation of the plan must be formulated. Tabulations include: a cost curve plotted by population of study area and costs per capita to conduct the study; and estimated time necessary to conduct the study as related to study area population.

68-1208

International Reference Centre on Waste Disposal. *WHO Chronicle*. 22(10):456, Oct. 1968.

An International Reference Centre on Wastes Disposal was established in September 1968 at the Federal Institute for Water Supply, Sewage Purification, and Water Pollution

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Control in Zurich, Switzerland. The activities of the center will comprise: the collection of basic data from different parts of the world on wastes produced; the development of rapid sampling and analytical methods for measuring pollutants; the evaluation of new methods for the collection, processing, reuse, and disposal of liquid and solid wastes; research on the construction and management of disposal plants; investigation of the health aspects of waste reuse, and disposal of liquid and solid wastes; and studies on the financial and economic implications of disposal and reclamation. One of the first functions envisaged for the Centre is the investigation and development of simplified methods for the solution of problems related to solid wastes.

68-1209

Japan. Ministry of Health and Welfare. A brief report on public health administration in Japan. *Asian Medical Journal*, 11(10):719-728, Oct. 1968.

The environmental sanitation report covers waterworks, sewage treatment, night soil disposal, garbage and trash disposal, insect and rodent control, and sanitary inspection and supervision. According to a survey made in 1962, only 36 percent of all night soil was disposed of by digestion plants and sewage systems. Fourteen percent was used for fertilizer in rural farms, and 22 percent was dumped into the ocean. At the end of March 1966, there were 792 communities operating night soil disposal plants. Incineration is the most common method for disposal of garbage and trash. A survey in 1963 showed that 42 percent of garbage and trash was incinerated. As of March 1967, the population benefiting from incineration and composting was 45,322,991. The environmental pollution control report covers air and water pollution and noise problems.

68-1210

Johnson, H. Selenium in solid waste. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York, p.C-11.

Since approximately 70 percent of the 800 million lb. of solid waste produced per day in the United States is paper, and since selenium is known to be present in almost all conceivable types of paper, environmental exposure to selenium is increasing through solid waste handling and disposal. The fact that selenium and its compounds are quite toxic, prompted an investigation by the Solid Wastes Program of selenium concentrations in solid waste. A fluorometric method for the detection and quantification of selenium was used. Newspaper, cardboard, and compost materials were analyzed to establish dormant or potential levels of selenium, and finished compost, incinerator residues, quench water, stack samples, and air samples, both near to and distant from incinerator sites, were analyzed to show the effects of the particular disposal method.

68-1211

Kershaw, M. A. The World Health Organization, with particular reference to the Division of Environment Health and to waste management and control. *Water and Pollution Control*, 67(5):561-567, 1968.

The constitution, organization, activities, and financing of the World Health Organization are considered. The division of environmental health deals with the problems of community water supply, environmental biology, environmental pollution, sanitation services housing, and waste disposal. The disposal of waste liquids and solids has been given great emphasis, as has the need for legislation to provide effective control of surface and ground water pollution in many countries. Education and persuasion are indicated as important factors in pollution abatement and control. It is proposed that an international reference center be created to promote uniform methods of analysis of waste water plant effluents, and as a testing center to evaluate the usefulness of new methods for collection, processing, and disposal of liquid and solid wastes. The various advisory services offered by the organization are also described.

68-1212

Klee, A. J. DARE—a decision maker's tool in the evaluation of solid wastes alternatives. In *Engineering Foundation Research Conference: Solid Waste Research and Development*, II, Beaver Dam, Wis., July 22-26, 1968. New York, p.F-6.

In solid waste studies it is often necessary to evaluate competing alternatives which are proposed to solve a specific problem. It is not always clear which factors are used to evaluate these alternatives. The 'DARE' (Decision Alternative Ratio Evaluation) technique is simple to use, cardinal in nature, and, although based upon the pairwise comparison rating concept, it drastically restricts the total number of comparisons required. DARE permits the incorporation of both qualitative and quantitative factors. Even though the presence of the former increases the subjectivity of the final scores, the fact that relative weights serve as inputs to the model insures that the decisionmaker's view of the system is clearly stated. Should quantitative data be available, they are easily incorporated.

68-1213

Klee, A. J., and G. A. Garland. Decision trees in solid wastes planning. *Public Works*, 99(7):74-77, July 1968.

One technique useful in resolving today's many alternatives in planning for solid waste disposal systems is decision tree analysis. These alternatives and their consequences can be reduced to the convenient graphic structure known as a 'decision tree.' The tree is comprised of nodes and branches, each node being of two basic types: squares, denoting decisions; and circles, denoting chance events. Probabilities are associated with chance events and must be considered along with other information such as financial data. It is unnecessary to consider returns that are not optimal with respect to output from nodes. An optimum solution to a decision tree is obtained via the rollback technique, starting from the right (farthest in time), by calculating values at each node as follows: if the node is a decision point, the values of the nodes leading from it are examined, and the optimum is selected; if the node is a chance event point, an expected value is calculated, using all of the nodal values at the ends of the branches emanating from it, and their probabilities. Since this approach ignores the question of risk, a risk analysis must be included along with the decision tree

analysis. This is accomplished by a modified form of a rollback technique, calculating nodal points from right to left. A hypothetical example is provided.

68-1214

O'Hara, A. S. Public health and the solid waste disposal problem. *Canadian Journal of Public Health*, 59(2):82, Feb. 1968.

Due to the greater volume of waste and decreasing availability of land for solid waste disposal, a crisis is developing in Canada. The collection, removal, and disposal of waste is essentially an engineering problem, and the aesthetics of disposal sites involve the public health officers. It is necessary that public health officials cooperate with municipal officials to ensure that basic sanitary criteria are satisfied. The provision of sanitary refuse containers, regular collection in proper vehicles, and final disposal in a manner which minimizes air or water pollution are basic criteria. The public health official must continue to direct and coordinate available technology to these ends.

68-1215

Porter, R. C., and F. W. Dressler. Tocks Island regional-interstate solid waste management study. In *Engineering Foundation Research Conference: Solid Waste Research and Development, II*, Beaver Dam, Wis., July 22-26, 1968. New York. (Conference Preprint F-5.)

The specific objectives of the Tocks Island study are to determine: the magnitude of the solid waste disposal problem; the present pattern of solid waste services; legislative requirements and standards; and the need for alternate solid waste disposal plans. Since the Tocks Island region will soon have a national park of some 72,000 acres, TIRAC (Tocks Island Regional Advisory Council) is providing local agencies with technical support and encouraging regional cooperation. During the first year of study, Solid Waste Inventory forms which provide basic data on population, generation and operational procedures for the study have been completed. The Steering Committee is composed of representatives of the Public Health Service, three State Departments of Health, the Corps of Engineers, and the National Park Service.

68-1216

Proceedings: A Montana Strategy for a Livable Environment, Helena, May 21-23, 1968. Montana State Department of Health, May, 1968. 112 p.

The goals of this conference are to attempt to set forth environmental problems and to establish a guide for the environment in Montana. Topics covered are: Recreation and Environment; Life's Prerequisite: Air; Focus on Consumer Protection; Water in the Environment; Disease in the Environment; Recreation vs. Industry for Montana; and Industry, Reaction, and Pollution. Montana cannot escape the environmental health hazards of the times. Like the great cities of this country, it must deal with the problems of substandard housing, air and water pollution occupational disease, and the beginning stages of urban blight. It is concluded that a partnership in the quality control of the

environment among Federal, State, and local health agencies is a necessity.

68-1217

Quality of the environment; residual management. In *Annual report for the year ending September 30, 1968*. Washington, Resources for Future, Inc., Dec. 1968. p.42-45.

A major undertaking of the year has been to formulate ways in which the production and disposal of wastes can be studied: the factors that affect the generation of wastes; the extent to which the environment can assimilate waste discharges; and the transformations that are possible among liquid, gaseous, and solid forms during their handling and disposal. The year's research on problems of residuals was a first step in a more comprehensive approach to environmental quality management. Mr. Bower, Walter O. Spofford, and Clifford S. Russell, visiting scholars, are engaged in this work. Basic to their approach is the concept that environmental pollution and its control involves materials and energy balance problems for the entire economy. One measure of the residuals problem is the difference in weight between the inputs to production and consumption activities, and the outputs from those activities. Mr. Kneese, Mr. Bower, Robert U. Ayres, and Richard J. Frankel have each worked on economic and engineering aspects of the residuals problem. Another contribution to the growing body of knowledge about wastes management was the report of the Regional Plan Association on the second regional plan for the New York region: *Waste Management*. As a consultant to the Association and co-author of the report, Mr. Bower was able to draw on the analytical application in an area conspicuous for its waste problems.

68-1218

Salvato, J. A., Jr. Environmental health and community planning. *American Society of Civil Engineers, Journal of the Urban Planning and Development Division*, 94(UP 1):23-30, Aug. 1968.

More environmental engineering in community planning is needed, with emphasis on area-wide, metropolitan, and regional approaches. Comprehensive planning, which takes into account all of the social, economic, and physical features of an area, followed by phased detail planning and capital budgeting, is significant for the immediate and long term economy and benefit of the people. Factors to be considered in a zoning plan for residential land use and major highway planning are cited. Frequently, Federal and State financial aid requires that single-purpose plans be made on a regional or area-wide basis. The planning process includes: (1) statement of goals and objectives; (2) basic studies, mapping and analysis; (3) plan preparation; (4) plan implementation; (5) public information and community action; and (6) reevaluation and continual planning. Environmental factors and needed improvements are identified. Responsibilities of State and local health departments include: water pollution abatement, waste water treatment and disposal, safe and adequate water supply, air pollution control, solid wastes disposal, x-ray and nuclear facility operations, and housing development. All environmental factors which may have a deleterious effect on man's physical, mental, or social well-being must be considered.

Management

68-1219

Thatcher, R. M. Optimal single channel service policies for stochastic arrivals. Operations Research Center Report 68-16. Berkeley, University of California, June 1968. 89 p.

The problem of finding an optimal choice between two given constant processing rates that have given operating costs is studied. Fluid material arrives in batches. Batch amounts have a general (known) distribution, and arrivals of batches follow a Poisson distribution. The holding cost is linear in current inventory level. If the same processor is always selected whenever a positive amount of material is in inventory, then the process is essentially an M/G/1 queue, and the stationary cost rate of the two processing rate problem is derived assuming a single inventory level, y , as a switch over criterion from rate 1 to rate 2 (y policy). The optimal y policy is found in terms of a simple implicit formula for y . It is proven that y is optimal for all stationary policies. The single rate service system, the dual rate service system, the class of y policies, and the optimal policy are discussed in detail. The model studied takes into account the fact that random arrivals will continue indefinitely in the future. This applies to the case of the sanitation district, where truck-loads of refuse are deposited at the city dump continuously, almost every day throughout the year. Optimality of a policy is defined, and properties of an optimal policy are developed.

68-1220

University of California, Davis. Food Protection & Toxicology Center. Can we conquer the solid waste mountain? Compost Science, 9(1):25-27, Spring 1968.

A major deterrent to the activation of properly conceived environmental control systems and programs, is the preponderance of agencies and governmental bodies with overlapping powers and structures, many of which are not cooperating toward an integrated approach to solving problems. Land, filled with solid wastes, is not suitable for construction of heavy buildings and homes without highly expensive foundations. Packaging technology must eventually produce materials which rapidly degrade when discarded, or materials which could have a secondary use that would be self-consuming. While no incineration plant in the United States is now meeting California air pollution standards, certain incineration systems in Europe meet all clean air requirements. It is believed that the raw garbage from the San Francisco area dumped in the Nevada desert will not act as fertilizer but will upset the ecological balance of the desert. An aggressive national sales program directed toward homeowners, parks, and similar outlets could result in a profitable market for compost. The ultimate goal of all disposal methods should be complete recycling.

68-1221

U.S. President's Council on Recreation and Natural Beauty. From sea to shining sea; a report on the American environment--our natural heritage. Washington, U.S. Government Printing Office, 1968. 304 p.

The President's Council on Recreation and Natural Beauty and the Citizens' Advisory Committee on Recreation and Natural Beauty were established by Executive Order of President Lyndon B. Johnson, May 4, 1966. The progress in

environmental improvement programs since the 1965 White House Conference on Natural Beauty is outlined. Present proposals and recommendations of the Council which will stimulate Federal, State, local, and private action to further enhance the quality of the environment and the beauty of the nation are given. Responsibility for action is considered in relation to government action, private action, education, and research. Included in the report are lists of books, pamphlets, and periodicals; films; local, State, and Federal agencies; and private organizations which can solve environmental problems. An index and many illustrations complete the text.

68-1222

U.S. President's Council on Recreation and Natural Beauty. The environment; the urban areas. In From sea to shining sea; a report on the American environment--our natural heritage. Washington, U.S. Government Printing Office, 1968. p.29-123.

The quality of the urban environment is examined from the appearance of neighborhoods to the management of the metropolitan region. Many forms of neighborhood improvement are being made possible through Federal assistance. Resident involvement in these programs is an important factor, especially in clean-up of vacant lots and dumps and small park development. Redevelopment of downtown areas and waterfronts, and preservation of historic sites are being conducted in some cities. Littering, a common sign of urban blight, is an expensive habit, costing the nation's taxpayers nearly one-half billion dollars each year. A combination of litter elimination measures that has proven effective in various communities includes: provision of attractive and frequently emptied litter baskets; establishment of maintenance standards and adoption and enforcement of local ordinances and State laws carrying reasonable, enforceable penalties against littering. The nation's solid waste includes 48 billion cans, 26 billion bottles and jars, and 65 billion metal and plastic caps per year. Today's conservation principles call for recycling waste for reuse wherever possible. Solid waste collection technology and management need to be improved. The Council recommends that the Federal Government be authorized to provide grant-in-aid assistance to establish regional solid waste managements which are integrated with regional liquid waste managements and air quality control systems and land-use planning. The Council also proposes that as soon as criteria are developed, pollution abatement efforts be operated as integral parts of regional waste management plans.

68-1223

U.S. President's Council on Recreation and Natural Beauty. The environment; the rural areas. In From sea to shining sea; a report on the American environment--our natural heritage. Washington, U.S. Government Printing Office, 1968. p.125-197.

A quality environment in the countryside derives from wise and careful husbandry that is in fundamental harmony with the land's ecology. Soil conservation efforts are reviewed. Insecticides, herbicides, fertilizers, and animal wastes have contaminated some components of the environment and should be fully recognized. The Council proposes that

Federal agencies cooperate with State and local agencies in encouraging the creation of privately developed commercial, recreational areas for public use in surroundings of natural beauty, and that consideration be given to enhancement of private lands for public enjoyment through cost-sharing of projects which improve rural scenic values. The Council also recommends that Federal agencies expand their programs of technical assistance to help States, local governments, and landowners preserve working farmlands, promote preservation of the scenic quality of private forest lands, repair past damage to landscape caused by surface mining, provide for regulation of the routing of high voltage transmission lines and other public utilities, assist rural community development planning, continue flood control and water resource development programs, expand fund sources for scenic and recreation lands, conserve wildlife, and designate natural areas.

68-1224

U.S. President's Council on Recreation and Natural Beauty. The environment; transportation. In *From sea to shining sea: a report on the American environment—our natural heritage*. Washington, U.S. Government Printing Office, 1968. p.199-299.

Transportation by its extent and its rigid physical requirement has a strong effect on most environments. Routing and design of highways, roadside development, billboards, junkyards, and roadside litter are reviewed. The environmental implications of three distinct forms of transportation are covered: pleasure driving, public transit, and air transportation. By 1966, about seven million vehicles a year were retired; this rate is expected to double or triple in the next 30 years. The most effective solution to the junk automobile problem lies in improving the disposal process. It costs American taxpayers an estimated \$100 million a year to pay for picking up highway litter. The Council recommends that the States make a vigorous effort with the tools and programs now available, particularly the Highway Beautification Act, to inventory, protect, and enhance the scenic and recreational values of existing and proposed roads.

68-1225

U.S. Senate. Subcommittee on Air and Water Pollution. Waste management research and environmental quality management. Hearings before the Subcommittee on Air and Water Pollution, U.S. Senate, May-July 1968. Washington, U.S. Government Printing Office, 451 p.

Hearings were held on May 22, June 3, July 9 and 10, 1968 before the Subcommittee on Air and Water Pollution of the Committee on Public Works, United States Senate, Ninetieth Congress, second session. The topics under discussion were the need to establish an important national environmental quality policy, with particular emphasis on waste management practices which minimize environmental pollution, and Federal research activities and strategies in air and water pollution control and solid waste disposal. Following the statements of various experts are reprints of selected reports and a name and subject index. Included in the selected reports are: Demonstration Projects Abstracts-Solid Waste Programs, State-Interstate Planning Grant Listing, and Summaries of Research and Training Grants in Solid Waste Disposal.

68-1226

Van Beek, G. Employee safety in the solid wastes industry. *Public Wastes*, 99(12):74, Dec. 1968.

A cooperative study performed by the American Public Works Association and the National Safety Council established that: the number of work injuries among employees of the solid waste industry is nearly 900 percent greater than the average of all industry in the U.S.; the severity rate is 300 percent greater than that of all industrial employees; and private contractors are spending a greater percentage of their gross income on accident costs than they are receiving in profits. Drivers and helpers on sanitation trucks should be appraised as to their mental, emotional, and physical capabilities, and should be trained to handle the equipment. Supervisors also require training in the basics of human relations and leadership principles. Direct benefits of employee training are reduction of accidents, lowered insurance costs, and increase in profits due to a decrease in downtime, overtime, supervisory time, and disrupted schedules.

68-1227

Vaughan, R. D. Statement. In U.S. Senate. Subcommittee on Air and Water Pollution. Waste management research and environmental quality management. Hearings before the Subcommittee of Air and Water Pollution, U.S. Senate, May-July 1968. Washington, U.S. Government Printing Office. p.184-198.

Public awareness of solid waste problems, waste management concepts and regional cooperation was stressed. Particular emphasis was placed on the development of new packaging materials and disposable containers. It was stated that all government agencies have been lax in inspiring and demanding preservation of the environment. Approximately 33 percent of the Solid Wastes Program appropriations for the fiscal year 1968 are for basic and applied research programs, and 50 percent of the research budget is provided for the nondirected research programs of educational and nonprofit agencies. Contract and grant programs are described in some detail. Recycling of resources was named as the ultimate in solid waste research and development.

68-1228

Wastes disposal. World Health Organization Chronicle, 22(7):309-310, July 1968.

Much of the work of WHO in wastes disposal takes the form of surveys and the preparation of requests to the United Nations Development Program for the financing of preinvestment and engineering feasibility studies. WHO is studying such subjects as sewerage, water supply, management and disposal of waste water solids and their integration with community and industrial wastes, the recovery and recycling of solid wastes, and new and improved treatment processes which use activated carbon filters, distillation, and electrodialysis. In 1967, a study was begun of simplified, low-cost designs for waterborne sewage disposal systems suitable for small communities in developing countries.

68-1229

Wilson, D. G. Summer study on the management of solid wastes; final report. v.I. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. 58 p.

The report covers three areas: immediate recommendations to cities and towns; future organization and procedures for managing wastes; and promising areas of research. The appendices contain individual views and recommendations not necessarily endorsed by the study group as a whole. A map of the Boston area showing expressway regions, cut and fill sections, cash and volume flow for Boston's solid waste, and a flow diagram of possibilities for solid waste management are included. The study group found that the solid waste field presented a picture which was confused for a number of reasons. There appeared to be emerging some waste treatment systems which may be better than the traditional methods of landfill and incineration, which themselves are capable of great improvement. Much work remains to be done in improving collection. The study group's strongest recommendation was that large, private firms or utilities should be developed to provide municipalities with large-scale comprehensive solid waste disposal services.

68-1230

Wilson, D. G. Recommendations to cities. In Summer study on the management of solid wastes; final report. v.I. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. p.5-13.

Any city producing less than 1,000 tons per day of refuse is urged to join with other cities in setting up some sort of intercity authority to reduce the cost of disposal. Large-area service organizations are also recommended. Sanitary landfills, and short-and long-distance hauling are discussed along with current incineration techniques. Incinerators could provide acceptable solutions to waste disposal at costs similar to those of other methods, there has been a varying amount of concern over the effects of chloride-containing plastics on incinerators.

68-1231

The WHO Solid Wastes Program (El programa de la OMS en materia de desechos solidos). Boletín de la Oficina Sanitaria Panamericana. 65(6):562-566, Dec. 1968.

The World Health Organization (WHO) has been operating in the field of health for more than 20 years. As part of its

program in the field of solid waste, it offers consulting-engineering services, demonstration projects, and training programs. It has collaborated with a series of countries, either by itself or with groups like the Special Fund of the United Nations Development Program, in such countries as Malta, Nigeria, Brazil, Argentina, Chile. It has also held seminars and courses in the field of solid wastes disposal and treatment. A meeting of the Scientific Group, held at Geneva in December 1966, dealt with the treatment and disposal of waste in both industrial and underdeveloped countries. The Group recommended the formation of an international, continuous, and systematic information program to facilitate international exchange of information on best practices. In addition to its collaboration with governmental and intergovernmental organizations, it has also participated in conferences on public health organized by the International Union of Local Authorities, in the Third International Congress of the International Group for Investigations on the Elimination of Wastes, and others. A brief list of WHO publications on solid wastes is given. (Text in Spanish)

68-1232

Wilson, D. G. Recommendations regarding future research, development, and design work. In Summer study on the management of solid wastes; final report. v.I. Cambridge, Urban Systems Laboratory, Massachusetts Institute of Technology, Sept. 1968. p.14-21.

Some of the present research and development efforts in waste disposal are discussed along with recommendations. A multipurpose transportation system to handle all the transfers of goods, and possibly people in high density environments, is suggested. Substantial gains can be achieved from the combination of trash collection vehicles and road-cleaning machines. More design and development work is advocated for current pulverizing machines. Very large gains can be had in the proper development of a new material separation machine. There is a strong need for an investigation to produce good information for an ideal compactor. Much information is needed on the influence of the air supply quantity, velocity, distribution, temperature, and pressure on the composting rate in composts. Incineration is dealt with in detail. Quantitative data on pyrolysis and hydrogenation are lacking. The presence of huge amounts of steel scrap from automobiles and old refrigerators is due to the change brought about in steelmaking by the introduction of the basic oxygen furnace. This furnace cannot accept as high a proportion of scrap as the open hearth furnace. Much design and development work is needed in this area.

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